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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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from Persons qualified to act as GENERAL MANAGER of the STATE SHIPBUILDING and DOCK YARD, WILLIAMSTOWN, VICTORIA. Applicants will be required to have first-class general engineering training with special experience of shipbuilding, dredge construction and steel structural work, also to have a capacity for organisation, to be conversant with modern business methods and expert in the control and management of men. Subject to satisfactory service, engagement to be for three years, terminating on three months' notice, but engagement may be renewed. He must not, for the term of appointment, engage in any employment, except as regards the duties of his office. Salary, £1500 per annum.
Age, qualifications, experience, &c., to be fully stated in applications, which should reach the Agent General for Victoria, Melbourne Place, Strand, London, W.C., not later than Eleven a.m. on Wednesday, 4th October, 1916.
PETER MCBRIDE, B 900
Agent-General for Victoria.

A Leading Engineering In-

surance Company has a VACANCY in its Boiler Department for an additional ENGINEER to take control of the reporting staff. Candidates must have had a thorough scientific and practical training with wide experience in the design and working of steam boiler plant.
Salary to commence at £600 per annum.
Applications, stating age and particulars of Engineering distinctions and scientific degrees (if any) to F 10, Offices of ENGINEERING.

Owing to Enlistment, a

vacancy occurs in the Engineering Department of the Bennett College. The SERVICES of an ENGINEER are REQUIRED as Assistant Tutor. One not eligible for Military Service, one with some Marine experience preferred, but not essential. Salary to commence £200 per annum.—Send particulars to the GOVERNORS, The BENNETT COLLEGE, Sheffield. B 993

BOROUGH POLYTECHNIC INSTITUTE,
BOROUGH ROAD, LONDON, S.E.

The Governors invite

Applications for the full-time

APPOINTMENT of an ENGINEER, qualified to undertake the superintendence of their Branch Institute (Herold's Institute, Bermondsey) in the evenings, and to teach general engineering subjects on five mornings or afternoons in the engineering section of the Polytechnic Technical School for Boys.
The salary will be £250.
Conditions of appointment and form of application may be obtained by sending stamped foolscap envelope to the undersigned.
C. T. MILLIS,
Principal. B 939

Chemical Engineer Required,

at once; must be thoroughly experienced and have sound education, and knowledge of high pressure gas plant. Liberal wages to first-class man. No person employed on Government work will be engaged. Write stating fully qualifications and details of experience.—Apply to your nearest LABOUR EXCHANGE, mentioning this paper and E 637

Chemical Engineer Required,

with practical experience of Nitric Acid, Sulphuric Acid Concentrating, Acid Mixing and Denitrating Plants. Must be good mechanical engineer, with some knowledge of Electrical Plant, and capable of handling men with tact. Please state age and full particulars of experience. Applications can be made in writing through your nearest LABOUR EXCHANGE, mentioning this Journal and B 863. No person engaged on Government work will be employed.

Cold Storage, Refrigerating

ENGINEER REQUIRED for abroad. Apply with copies of testimonials, state age, if married, details of experience and salary required; must be ineligible for Army. No one already engaged on Government work need apply.—Apply, to "T," BOX, 778, T. B. BROWNE'S Advertising Offices, 163, Queen Victoria Street, E.C. B 711

Practical Engineer Wanted,

in Eastern Counties, to superintend running and maintenance of several Gas Engines and Suction Plants. Permanency for suitable man. State age, experience, wages, &c.—Address, F 16, Offices of ENGINEERING.

Wanted, for Large Steel

works near Glasgow, an ASSISTANT to the Chief Engineer.—Apply, to your nearest LABOUR EXCHANGE, stating qualifications and experience, mentioning this Journal and B 985. No one already on Government work need apply.

Young Engineer with Draw-

ing Office experience, ineligible, REQUIRED for North London. One accustomed to general factory work. Give fullest particulars, with salary required. No one employed on Government work will be engaged.—Apply, nearest LABOUR EXCHANGE, mentioning this Journal and B 972.

Wanted Immediately, by

Engineers in Manchester, experienced GENERAL CLERK, male; one with some experience of purchasing preferred. No one already employed on Government work will be engaged.—Apply, with full particulars, stating experience, age, and salary required, to nearest LABOUR EXCHANGE, mentioning this Journal and F 26.

Wanted, Assistant Cost and

ESTIMATING CLERK for large Engineering Works. No one already engaged on Government work will be engaged.—Apply, stating age, experience, and salary required to the nearest LABOUR EXCHANGE, mentioning this Journal and B 984.

Shop Superintendent (Male)

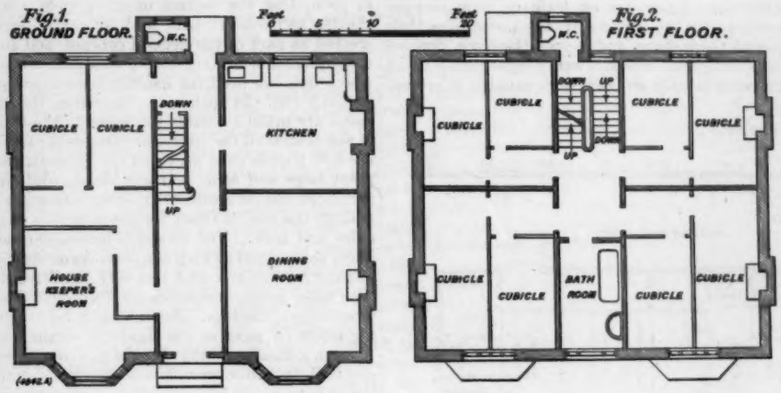
REQUIRED, for controlling 150 female workers on small engineering detail assembling work, sheet metal welding, fitting, &c. Should be good organiser with knowledge of hand repetition work. Write, stating age, details of experience, and salary required. No one on Government work need apply.—Apply, nearest LABOUR EXCHANGE, mentioning No. A 2305. F 12

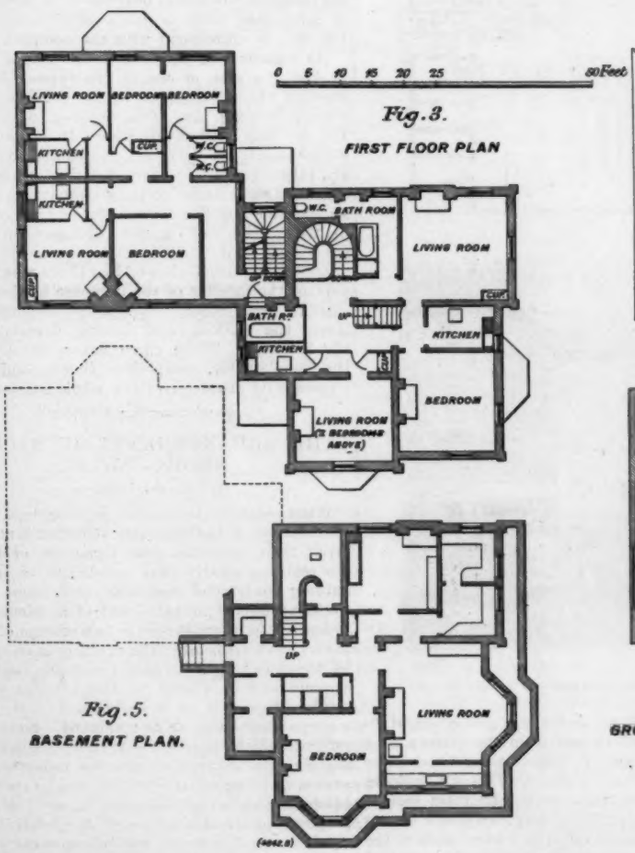
THE WELFARE OF MUNITION WORKERS.

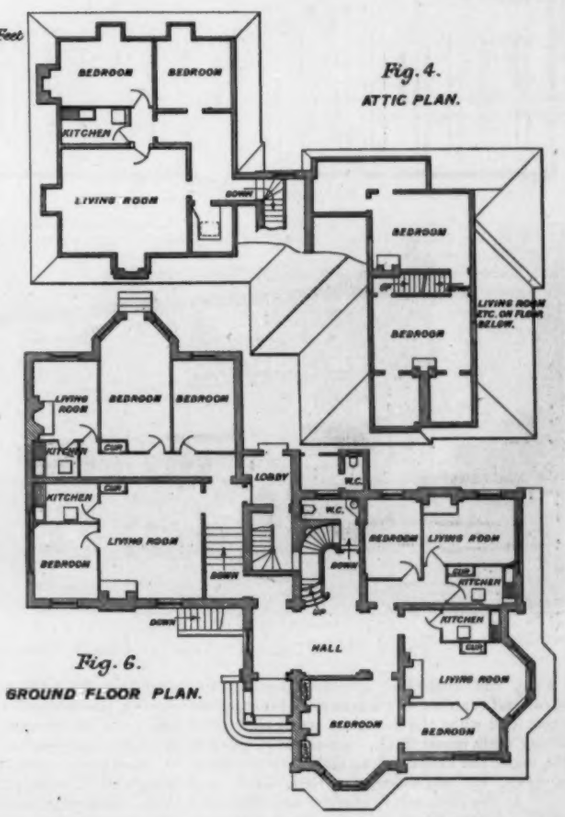
ONE of the difficult problems set to the great employers of labour, as a result of the enormous demand for munitions and the consequent great accession to the number of workers, was the accommodation of the latter and the provision for their welfare generally. In large communities this has not proved such a pressing question, but in view of the fact that there has been in recent years a tendency to erect engineering and other factories in more or less rural districts, in order to ensure healthier environment and to reduce the cost of living, the sudden augmentation of the works and of the number of workers at once created a grave difficulty in providing quickly the required accommodation. The method of solving the problem adopted by Messrs. Vickers is interesting, not only for the completeness of the details of organisation, but as indicating possibilities for the future in connection with one of the difficult social questions of the day; establishing, as it does, the success, when well organised, of isolated dwellings with co-operative means of supplying food and other domestic services.

It became necessary, in one of the districts where the firm have works, to provide accommodation for several thousand workers, with their families. To have attempted the erection of dwelling-houses would have absorbed a number of builders, who were not available. Moreover, at the end of the war there might not have been employment in the particular district for so many men. It was, therefore, decided to secure certain public buildings and schools, and, in addition, to rent all available large private houses, even when they were in isolated positions, and to convert these public buildings, schools and large dwelling-houses into flats or small dwelling-houses with one or two bedrooms and a sitting-room, or into separate cubicles. Others were formed into canteens and large recreation rooms, and one of them into a hospital with 200 beds, with an operating theatre and all the accessories of such an establishment, along with separate medical and nursing staffs. This latter, by the way, was a wise provision, and has been found of great public service, because the existing hospitals have all been taken over for wounded soldiers. In no case have the large buildings been arranged as dormitories, as it was found that the men employed by the firm—mostly mechanics—each preferred a separate cubicle to himself. Thus, some of the large houses are divided up into separate cubicles. There was, too, considerable difficulty in the utilisation of these large dwelling-houses, owing to the diverse nature of the workpeople to be accommodated; they included single men, single women, young boys, young girls, and married couples with and without families. The men, again, belonged to different nationalities, including English, French, Belgian (French and Flemish), Dutch, Danes, Swiss (French and German), Canadians, Americans and Spaniards. The cubicles are illustrated in Fig. 1, which shows the ground floor of one of the buildings, and in Fig. 2, which represents the first and upper floors. In these houses a married couple with a family takes charge. In other cases the dwelling-house was divided into flats. In some instances one large room was converted, by temporary partitions, into a bedroom, living-room and kitchen. Figs. 3, 4, 5 and 6 show the arrangement of the four floors of such a dwelling-house.

In the case of flats and single-room tenements a gas stove is fitted in each, with a penny-in-the-slot gas meter. In the general hostels, where the people are on the board-lodging terms, a kitchen is provided, together with a cook-housekeeper and the necessary staff, so that all meals can be cooked in the hostels and served while the tenants are there and are not in the works. In the works the tenants get their food at the canteens by means of vouchers provided for them by these hostel keepers. Such vegetable gardens as the large houses possessed were utilised in connection with the department; a farm was secured, and the whole scheme developed on great







broad lines. The catering department provided the furniture, crockery, and such local heating appliances as were necessary in the house; it has, moreover, a thoroughly well-equipped central cooking establishment, so that everything is done to secure a great variety of food of the best quality. The area covered by the hostels is 120 square miles, and in order that the food could be served over the required area a small fleet of motor vehicles was purchased, all with means for keeping the dishes hot in transit. Fig. 8 shows some of these vehicles at the cooking department. At the same time canteens were built at the works, and thus the men or women engaged are, when at the works, fed at the canteens, whether on day or night shift, or are fed at home when they are at home. This applies also to Sunday. Even the napery and table linen and other appliances are

Fig. 7.

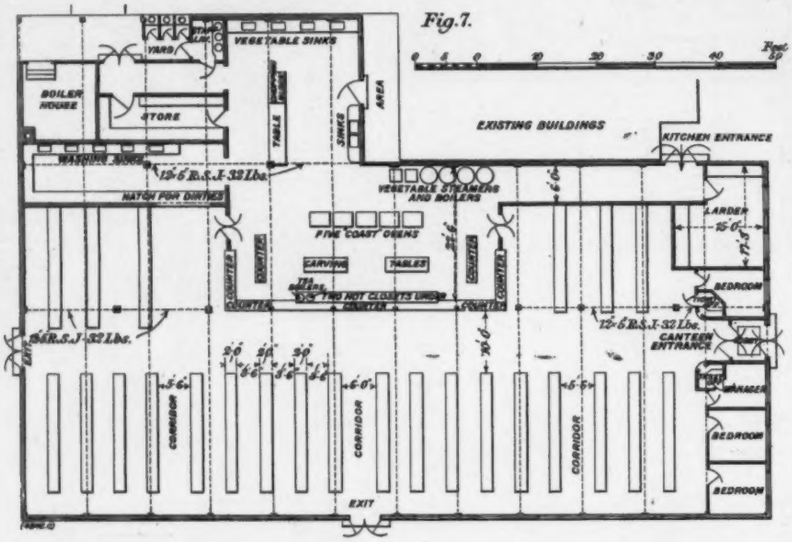


FIG. 8. FOOD DELIVERY VANS AT COOKING DEPARTMENT.

taken away and washed in a central department. The wives and families of workers are also supplied with their food when the husbands are at the works and taking their meals in the canteens. It was not possible, under the Truck Act, to make any provision for payment, by deduction, for rent, food and service. A comprehensive charge was therefore arranged, including housing, use of furniture, table linen, bedding, crockery, washing of table and bed linen, gas supply, water supply, cooking, and all food. Mineral waters and beer can also be had. It was considered that by allowing beer to be supplied in this way the men would be more inclined to remain at home than to go to licensed places for their beer. The charges are as follow:—

	Per Week. £ s. d.
Single men	0 18 6
Married couples	1 10 0
Children living with parents, boys or girls, up to eight years old ...	0 4 6
Children living with parents, boys or girls, between eight and fourteen	0 5 6
Children living with parents, girls, between fourteen and eighteen...	0 14 0
Women over eighteen	0 14 0
Boys between fourteen and eighteen	0 14 0

Some of the women employed belong to the highly-educated class, and a special hostel has been provided for them, where the charge is 18s. per week.

It will be understood that the hostels are widely distributed. There are no train or tram services convenient for the workers in their travel from their house to the factory, and it was, therefore, decided to provide special means. Twenty-eight char-a-bancs were consequently ordered, each capable of accommodating 40 workers, and these are arranged to convey the workers to and from the factory at a charge of ½*d.* a mile. A special garage had to be provided for these char-a-bancs. This is a building of brickwork with 14-in. walls, the main section being 120 ft. wide by 75 ft. deep, with four sliding doors occupying practically the whole width of the 120 ft. In front there is provided an asphalted washing space, 30 ft. deep, with satisfactory drainage arrangements for carrying away the water. A special tank is built under the ground level, and in the building there are arrangements made for the chauffeurs' mess-room, stores, offices, &c. A repair department is provided to the rear, 30 ft. by 60 ft., with motor pits 3 ft. 9 in. deep. Adjacent to this is the tyre store, while the carbide store for the provision of material for acetylene lights is entirely isolated.

The interest of the management did not end with the material requirements of the workpeople. A chaplain was appointed, who, before taking Orders, had served for several years in a large engineering firm, and had consequently intimate knowledge of the workpeople and acquaintance with their work. He was appointed generally as adviser to the workpeople, and the Bishop of the district has expressed great satisfaction with his work. The chaplain's duties include, *inter alia*, the settlement of disputes among the families living in each hostel, attendance on the children, the organising of concerts and recreation, and generally to assist in promoting the welfare of the people. A large theatre and concert hall, with an organ, has been erected as part of the general scheme, and suitable entertainments are organised, even on Sunday, on which day the need for healthy recreation is most urgently felt. In such cases, of course, the char-a-bancs are made available for bringing the residents of the hostels to the concerts. Attached to many of the 200 hostels thus provided are gardens, some of them large and some of them small, while an experienced market gardener is exclusively engaged for making the best of these, for the provision of vegetables and fruit. The residents having gardens are being encouraged to keep the portions of the gardens bearing flowers in a neat and tidy condition during their spare hours, and prizes are being offered for the most artistic displays. This has had a very encouraging effect on most of the residents at the hostels.

As an indication of the effect of this comprehensive and well-devised scheme, it is interesting to note that the charges made by boarding-houses accommodating munition workers as boarders have been reduced, in some cases from as much as 27*s.* per week to 18*s.* 6*d.*, to correspond with the company's tariff.

As regards the canteens at the works, we give in Fig. 7 a plan of one of the typical buildings, showing the arrangement of the public room, the serving benches, &c. This building, as shown, is 126 ft. long and 60 ft. wide. It is built up of stanchions 5½ in. by 4½ in., on concrete bases 3 ft. sq., taken down to a firm bottom. On page 228 there are three views of these canteens. Fig. 9 is an exterior and Fig. 10 an interior view of a type in which the well-known Belfast timber roof trusses are used. In Fig. 11 a view of the interior of another canteen is shown. Fig. 12 is a view showing part of the interior of the immense kitchen in the catering department. Figs. 13 and 14 show respectively the washing and ironing departments of the laundry. These three latter views indicate the completeness, comprehensiveness, and labour-economising character of the whole scheme.

THE ARRANGEMENTS OF MACHINE SHOPS.—No. IV.

By JOSEPH HORNER.

WITH regard to the subject of shop lighting, this is one to which vastly greater attention is now being given than was the case formerly. Employers are realising clearly that insufficient or improper lighting are fruitful sources of inefficiency, of poor workmanship, of mistakes and of accidents. Provision has to be made for the two sources of light—natural and artificial. The problem is complicated by the very variable character of the daylight in summer and in winter, by the different kinds of artificial light that are available, and by the various ways in which each can be employed. So the whole subject, which troubled old-time engineers but slightly, now assumes a first-class importance, and advice is tendered thereon by rival experts who advocate the several systems in use. It is not proposed to attempt to weigh the relative merits of these rival systems beyond pointing out the general character of their several utilities in the machine shops. The following observations will relate in the main to the requirements and problems of efficient shop lighting, and to the most suitable methods of meeting and solving them, with references to the systems which are in use.

Natural light, to be fully utilised, must be that which comes through roofs. It may be supplemented by that from windows in walls. These alone are made to suffice in storied buildings, and in offices. But they must be of large dimensions, otherwise the dead walls between the windows are in

shadow on dull days. Many shops which have enough light on bright summer days lack a sufficiency in winter, involving the cost of artificial lighting later in the morning and earlier in the evening, and more during some portions of the daytime than would be needed if window areas had been liberally provided. Abnormally dark days are exceptions, when artificial lighting must be fallen back on even in the best arranged system.

Though the requirements of a workshop demand ample lighting it should be without glare and brilliancy. To avoid the blinding glare of sunlight is the reason why the saw-tooth roof (such as that illustrated in Fig. 20, on page 193 *ante*), with windows on the north slope only, is now so largely adopted. And no other light is admitted in this shop. The same object of avoiding direct light is sought by the use of blinds and shades to the windows in walls, of shades to lamps, and by methods of diffusion such as the use of dead light, or neutral tints for ceilings and walls. Some of these aspects are so well fulfilled by suitable systems of artificial lighting that many shops are more comfortable to work in by artificial illumination than others are by daylight. This is a matter, too, of growing importance, because of the increasing employment of night shifts. The very variable character of the supply of natural light in a shop which has been constructed with ample window area, suitably arranged, renders the light effects extremely variable. But artificial illumination is constant, in the absence of any breakdown in the supply system.

To provide for the exigencies of dull days, the lighting areas must be proportioned on a liberal basis to harmonise with the reduced amount of lighting, and provision be made with blinds and by a dull neutral tint for the even diffusion of the excess of light.

The cardinal problems, therefore, which occur in the lighting of the machine shops are first, intensity, sufficiency—the quantity of light admitted; second, its regularity—equal distribution to avoid lighter and darker areas such as occur when machines and benches are located opposite to and between windows in walls; third, its regular diffusion, by which is meant the avoidance of glare and of brilliancy, which is effected by light or neutral colouring without gloss, a dull tinting.

Sufficiency of light is a matter for calculation. This, too, is being standardised, like almost every other item and detail. The Illuminating Engineering Society, of New York, has issued a Code of Lighting for Factories. Artificial light is taken as the basis. And the daylight conditions are given as being three times the minimum intensities adopted by the code for artificial light. The difference is explained by the accommodation of the eye to artificial illumination. The eye requires more natural light for satisfactory vision than artificial light. This code gives 3.50 minimum foot-candle intensity for fine manufacturing operations, and a desirable foot-candle intensity ranging from 3.50 to 6.0. For special cases of fine work it ranks as high as 10.0 to 15.0 foot-candle intensity, for rough manufacturing operations as low as 1.25 to 2.5. 3.50 is the minimum which is considered suitable for the ordinary operations of the machine shop, but 5.0 is regarded as a standard. These intensities are measured in foot-candles on a horizontal plane.

Foot-candle intensity denotes a standard that is related to candle-power, but which must not be confounded with it. The foot-candle standard signifies the intensity of the illumination which is produced by a light of one standard candle-power on a surface 1 ft. distant from it, and lying at right angles to the rays from the source of light. So that the candle-power itself is related to the distance of the surface illuminated from the source of light, and varies inversely as the square of that distance. It also varies with the angle of inclination which the rays of light make with the perpendicular when the source of light is not situated over the surface illuminated, varying then with the cube of the cosine of the angle made.

The actual amount of light obtained may be very much lower than that which the theory would suggest, and therefore close attention must be given to the elimination of the losses that arise from many sources which remain to be considered.

In one of the annual reports of the Chief Inspector of Factories and Workshops it was pointed out that the minimum illumination of any workshop would be regulated by the albedo, or natural amount of light reflected from a body. That of dull iron is low, and therefore good illumination is necessary. He also observed in regard to machine shops that he found the daylight illumination of different parts of the benches varied from a minimum of 1.6 foot-candles to a maximum of 67 foot-candles, and under artificial illumination from 0.84 to 32 foot-candles. Enormous differences these, which reveal the chaotic condition of shop lighting.

The relation which exists between the natural daylight and artificial is not readily determined, nor are the losses which occur in transmission through windows. The intensity of the natural light outside has been estimated at 100 candles per square foot on dull days, reduced to 75 candles per square foot where it passes through shop windows. Its value elsewhere than at the windows depends on its distribution and diffusion.

The amount of light admitted through windows cannot be too ample, provided it is distributed properly. Generous areas of glass are therefore provided in new shops, being frequently continuous along the entire length of roof, as in Figs 19 and 20, on pages 192 and 193 *ante*, and of good width. In saw-tooth roofs (Fig. 20) the whole of the north slope is given to glass. Supplementary lighting from side windows is frequently abandoned because it produces shadows, and occupies wall-room that may be utilised for shelves, racks and pegs.

Equal distribution of light is obtained by a suitable arrangement of window glass, in contrast with relatively large roof or wall areas and small window areas. The problem is most easily solved by the continuous roof skylights illustrated, which admit the light at a moderate angle. Storied shops are placed at a disadvantage, which can only be met by the employment of large window areas. Wide floors, then, are necessarily dependent on artificial light on dull days. The benches and machines that are next the windows are subject to direct glare, and those about the centre are often in shadow.

The equal diffusion of light is another way of stating the softening effects produced by ribbed glass, by shades, blinds and neutral tints of paints, all of which tone down strong sunlight and excessive brightness. Work cannot be done properly when the eyes are dazzled by an excessive amount of light. For although the pupil of the eye has a large power of unconscious self-accommodation, it will contract so much under strong light as not to admit sufficient to work by properly, besides which there is an extra strain thrown on the retina and optic nerve. The general illumination, therefore, should be of a uniform character. If it is very bright in places, and in shadow in others, the result is inefficiency and eye-strain, with, on dull days, frequent recourse to artificial lighting in the shadowed localities.

In attempting to estimate approximately the candle-power which daylight transmits through a window two points must be remembered. One is that the estimation must include only the area of glass through which the sky is actually visible. That is, if the wall of an adjacent building comes into the line of vision, the portion of the window in which it interrupts the skylight must be deducted. One of the advantages of roof light is that obstructions of this kind do not occur. The other fact is that the candle-power which is transmitted direct through a window must be divided by the square of the distance from the window to the surfaces of the machines or benches in order to find the candle-power actually available for working by. Nor is this all, for the assumption is that the glass is clean, which is often not the case. Therefore, frequent cleaning of windows is a matter of sound economy.

The problems of artificial lighting are more involved than are those which are concerned with daylight, and they admit of several solutions. But the same general rules and principles apply equally to each. The same problems—those which concern the intensity of the illumination, its regular distribution, and its equal diffusion—arise, and are solved by suitable selection and arrangements of lamps and shades. Two rival systems of lighting exist, gas and electricity, each with alternative methods of utilisation. The intensity of the light derived from artificial sources estimated as the candle-power of lamps should be translated into the foot candle-power standard of shop lighting to be standardised. Since the amount of illumination delivered at the machines varies with the square of the distance between the machines and the lamps used, the height of a shop must be a vital factor in determining the selection of the lamps. Arc lamps are more suitable for lofty shops than others. For shops of low or medium height other lamps are adapted. In addition, provision must generally be made for the local illumination of machines and benches, for work in course of erection, for working on vertical faces, and so on, conditions which were formerly met by gas brackets, and by candles and oil lamps.

As in daylight illumination, too, the nature of the reflection from the walls and ceiling has a very modifying influence, as also has the obscuring effects of glass lamp-shades. For these the light and neutral tones are the best. Dark colours and tints absorb large quantities of light and reflect comparatively small amounts. Lamp glass absorbs so much light that the rating must be estimated with the globes in use, and not as that of the naked light.

In considering and comparing artificial systems, each must be weighed solely in relation to the particular design of a shop and of its working requirements. The aim should be to make the artificial service fulfil as nearly as possible the functions of natural light.

The intensity of artificial lighting is secured either by employing a few lamps of high power, or a large number of lamps of lower power. The arc lamps represent the first, the tungsten lamps, the mercury vapour lamps, the incandescent gas burners equipped with mantles the second. Equal candle-power may be secured in either selection and equal foot-candle standards, but all are not equally suitable for all machine shops. The regular distribution of artificial light is secured better by some kinds of lamps under certain conditions than by others.

In lofty shops the overhead arc lamps provide a good distribution of light. If they are installed in sufficient numbers no dark areas are left in the shops. But if a shop roof or ceiling is low, these lamps are not so economical as are those of other kinds. The suitable limiting height is set at about 20 ft., at which and beyond the arc lamps are used to advantage, giving a powerful light with good distribution. The higher the shop the greater is their value, not only on account of the better dispersion of light, but also because their brilliancy is less dazzling to the eyes of the workers. There is an extensive choice of these lamps, ranging from the older carbon arc lamps to the flaming carbon types, with an immense range in candle-power, and in the kinds of globes that surround the light.

In the arrangement of roof lights it is well when practicable to avoid or lessen the shadows cast by belts and overhead cranes. Thus in the machine shop of Messrs. A. Ransome and Co., Limited, illustrated in Fig. 18, on page 191 *ante*, the arc lamps are situated, as already noted, below the cranes and at the sides of the shop.

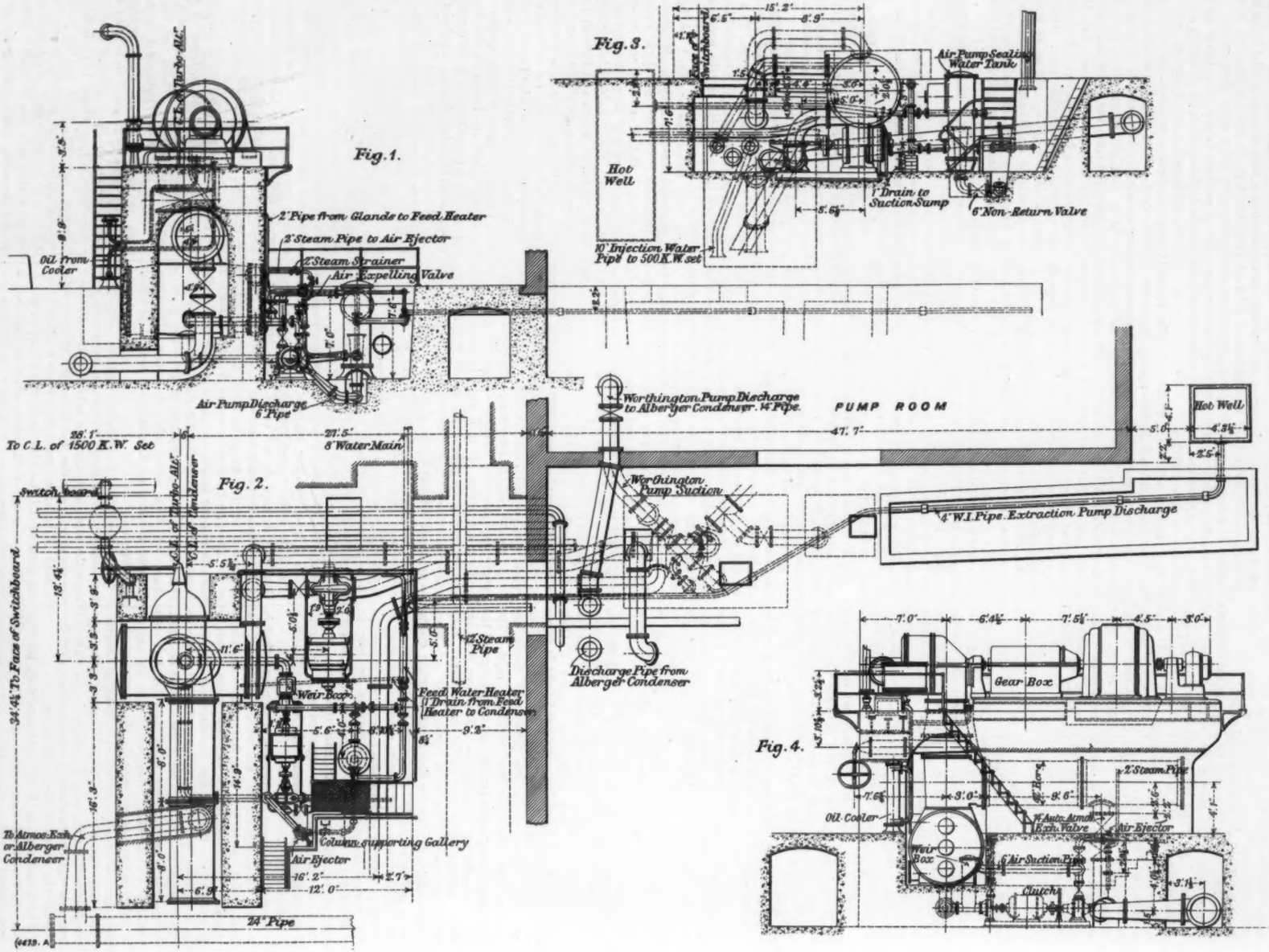
In low shops and in side galleries the filament lamps are better than arc lamps. A much larger number are required, but the illumination is more evenly diffused. The mercury vapour lamps are also suitable. Each of these has the great advantage of requiring practically no attendance, while the arcs do.

To these must be added the employment of small filament lamps, fixed, or portable for some classes of fine machine work, the shape of which throws portions into shadow. These may be rendered a measure of economy in lighting if the nature of the work is largely of the kind mentioned. It is obviously more economical to employ these lamps, with moderate supply of diffused light, than to have a very large supply where it is not required. This principle, however, must not be pushed too far, because extremes of lighting are bad for the eyes. But it is to be considered in certain circumstances, and each shop is a law to itself. Where machines are not crowded, where wide gangways and large vacant spaces occur, the general lighting need not be so intense as under the contrary conditions. It

1500-KW. GEARED TURBO-GENERATOR AT THE WESTINGHOUSE WORKS, TRAFFORD PARK, MANCHESTER.

CONSTRUCTED BY THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, MANCHESTER.

(*For Description, see Page 222.*)



GEARED TURBO-GENERATOR AT THE WESTINGHOUSE WORKS, MANCHESTER.

CONSTRUCTED BY THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, MANCHESTER.

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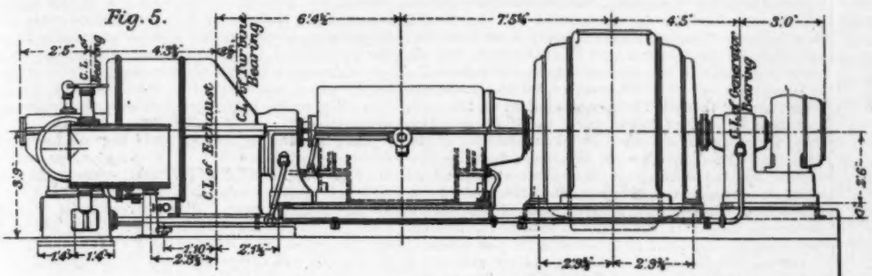
Fig. 5.



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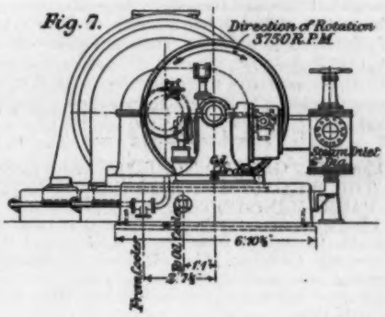

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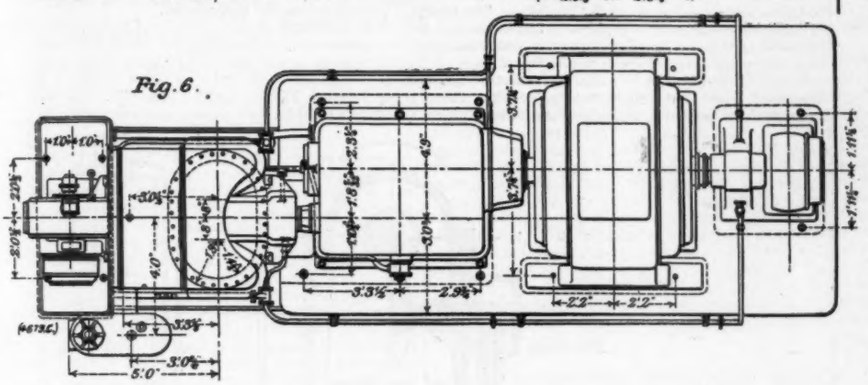


Fig. 8.

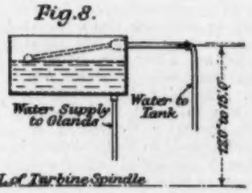


Fig. 20.

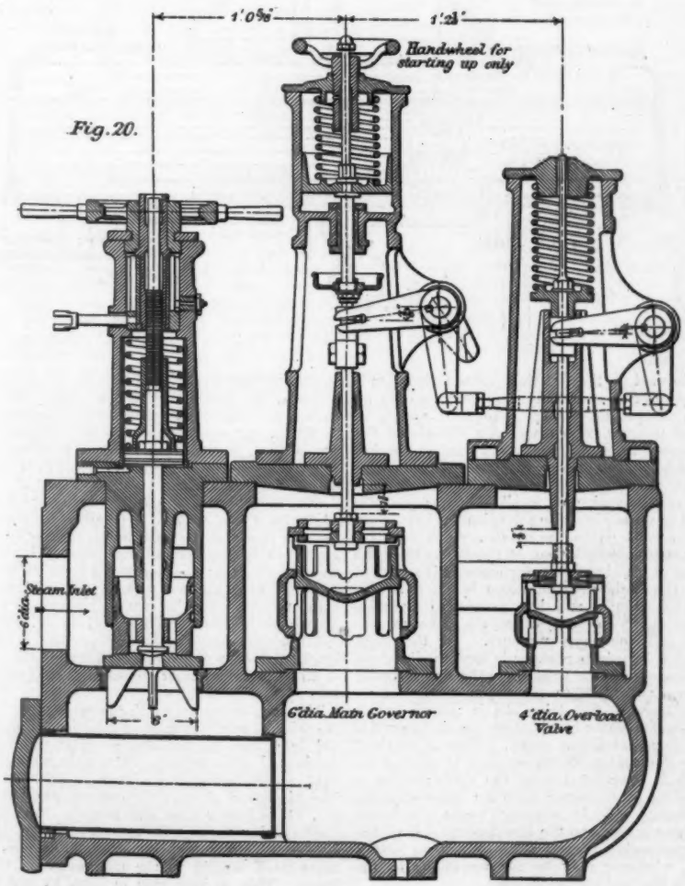
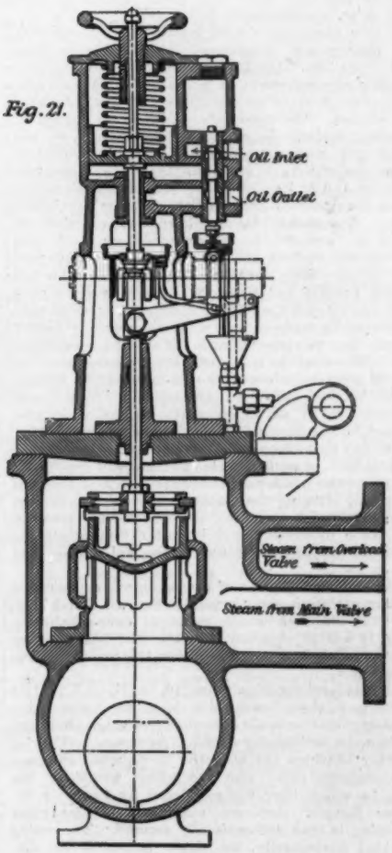


Fig. 21.



is better that the general illumination should be toned down than that the glare of powerful lamps should distress the eyes of the workman when he turns from his machine or bench.

In laying down an installation it is better not to attempt to estimate closely on the basis of empirical data and formulæ. Approximations may be made in this way, but it is safer to adopt existing installations as a basis. There are plenty of well-lighted shops now. The lamp-makers are prepared to supply estimates which may be accepted without reserve when a firm has determined on a system of lighting.

1500-KW. GEARED TURBO-GENERATOR AT THE WESTINGHOUSE WORKS, TRAFFORD PARK, MANCHESTER.

OWING to the steadily increasing load at their power station the British Westinghouse Electric and Manufacturing Company, Limited, recently decided to replace an existing slow-speed reciprocator-driven generator of American manufacture by a steam-turbine driven unit.

When planning the change three alternative schemes were carefully considered. The works periodicity was 25 cycles per second, and these three schemes were as follows:—There was already in use at the station a 1,500-kw. set running at 1,500 r.p.m. which had proved very satisfactory, and one obvious proposal was simply to duplicate this set. Another suggestion considered was to instal a high-speed turbine, direct-coupled to an alternator with a corresponding periodicity, from which a motor generator set would be driven. The third plan, which was that ultimately adopted, was to couple a high-speed turbine to a slow-speed alternator by means of gearing. This arrangement proved to be the lowest in ultimate cost, since although the initial outlay required was, owing to the gears, as high as that of the slow-speed turbo-alternator, the steam consumption would be 10 per cent. less owing to the more favourable ratio of blade speed to steam speed which became practicable with the higher revolutions of the turbine per minute.

The reduction gears were supplied by the Westinghouse Machine Company of Pittsburg, U.S.A., and are, we believe, the first provided with a floating frame to be seen in this country. The turbine as built runs at 3,750 r.p.m., and is rated at 1,500 kw. The gearing transmits this load to a slow-speed alternator with salient poles, which runs at 750 r.p.m.

The new plant had to be installed in the existing power station and is arranged as indicated in Figs. 1 to 4, page 220. The turbine, the gear-box, and the alternator are mounted on a concrete platform (see Fig. 4), some 9 ft. or so above the ordinary floor level of the station. The condenser, which has 4,300 sq. ft. of cooling surface, is arranged transversely to the turbine axis and immediately under the exhaust branch, to which it is connected by a large tee-piece, the third leg of which (42 in. in diameter) couples the system to the condenser of the previously existing slow-speed turbo-alternator, so that in case of an accident to either condenser, each turbine can use the other. This 42 in. pipe was provided in the first place to connect turbines on the adjacent turbine test-plate to the new surface condenser having 4,300 sq. ft. of surface, this condenser being specially made of such a size to obtain a higher vacuum than was possible with the existing condensing plant. Whenever the new condensing plant is used for the new geared turbo-set the 42-in. exhaust branch will be blanked off. An atmospheric exhaust and a connection to an Alberger jet condenser is also provided for, as shown at the left-hand bottom corner of Fig. 2. Two alternative systems of air pumps are also provided, in part because under present conditions a failure of the plant would be serious from a national standpoint, bringing the works to a stop, and in part for demonstration purposes, the firm having recently made some interesting and important improvements in their air pumps and ejectors, which will be described later.

A general arrangement of the turbine and generator to a larger scale is reproduced in Figs. 5, 6 and 7, on page 221, which show the principal over-all dimensions. It will be observed that the gear-box occupies nearly as much floor space as either the turbine or the generator.

From the sections, Figs. 9 and 10, on Plate XXIII, it will be seen that the turbine is a Rateau machine comprising one velocity compounded stage, followed by seven simple impulse wheels. As shown in Fig. 10, the rotor bearings are mounted in separate castings. These castings carry also the whole weight of the casing to which they are registered by turned semi-circular flanges. Accurate alignment of the rotor and casing is thus automatically secured. The casing is divided horizontally, the upper halves of the diaphragms being bolted to the top half of the casing. In lifting the top half no pipe joints have to be broken or valve gear dismantled, so that access to the interior of the turbine for examination or repair is easy. The diaphragm packings are of the labyrinth type, the strips being mounted on rings which are dovetailed into the diaphragm, so that each packing can be replaced as a unit if required. The details of the Rateau wheels and blading, as constructed by the British Westinghouse Company, have already been described very fully in our columns (see ENGINEERING, Jan. 13, 1911, page 40), and the same system is still followed.

The blades are of 5 per cent. nickel steel, and are milled out of the solid. They are forked at the root, and these forks straddle the rim of the wheel on which they are mounted and are secured in place by rivets. This plan is followed for all the single-stage impulse wheels, but the blading for the velocity compounded wheel is secured in a different way, the roots being dovetailed into slots turned in the rim. A very ample factor of safety is adhered to throughout, although the mean blade speed is about 675 ft. per second.

The diaphragms are of cast iron, and are split along the horizontal axial plane of the machine. The blades, of mild steel, are cast into place. In the case of the earlier stages the admission is partial, but is complete over the whole circumference in the later.

It will be noted that the bearing pedestals are well separated from the turbine casing, so that there is little flow of heat to them by conduction. This is further diminished by the fact that water-sealed glands are provided, and the shaft is accordingly cooled by these as it leaves the casing. The high speeds of rotation now popular have materially diminished the energy expended in these glands, the frictional resistance of which increase nearly as the fifth power of the diameter, but only as the cube of the revolutions. With high speeds a pipe of small diameter provides the full head required for sealing the glands. In starting up steam is turned on to the glands, which are thus temporarily steam-packed; but at about one-third the normal speed of working the water pressure is sufficient to provide the seal, and the steam is cut off. The gland at the exhaust end has merely to maintain a head equivalent to the difference between the atmosphere and condenser pressure. At the high-pressure end a labyrinth packing is used to wire-draw the steam down from the pressure in the first chamber to a vacuum of about 20 in. of mercury. The steam which leaks through this labyrinth is passed into a surface feed-water heater provided on the discharge side of the condensate extraction pump. Thus all the heat contained in the leakage steam, as well as that of the steam which is evaporated from the sealing water, is recovered, while at the same time the water gland on the high-pressure side is working under conditions similar to those existing on the low-pressure side of the turbine. Once sealed, these glands require no further adjustment, whatever may be the variations in the vacuum or in the load on the turbine.

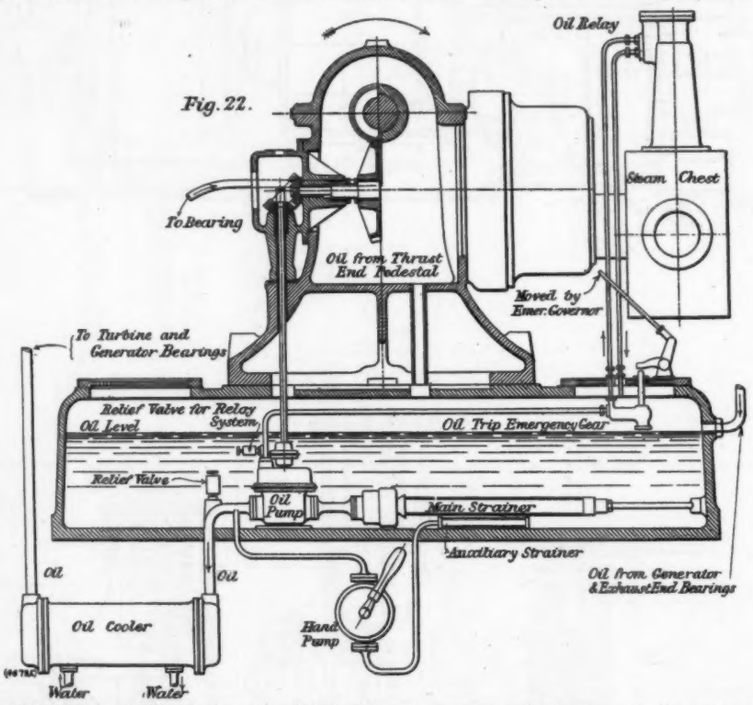
At the high-pressure end the shaft is fitted with the usual thrust or alignment block. The emergency governor is also fitted at this end. This consists simply of a plug fitting in a hole drilled transversely to the shaft axis. This plug is heavier at one end than at the other, so that under the action of the centrifugal force developed it tends to fly out, and this tendency is resisted by a spring. The strength of this spring is adjusted so that when the shaft speed rises about 10 per cent. above normal it is no longer able to resist the centrifugal force. The plug accordingly moves out and trips a trigger, thus opening a valve on an oil relay, which maintains the engine stop valve open. The oil pressure being thus released, this valve closes automatically.

The working governor and the oil pumps are driven by a skew-bevel or worm gear, as indicated in Fig. 9, Plate XXIII, and more completely, although to some extent diagrammatically, in Fig. 22, on the present page. The governor is, it will be seen, mounted horizontally, and at the tail end its spindle drives by bevel gearing a vertical shaft, which at the one end drives the main oil pump, and at the other actuates the tachometer.

As indicated at the right-hand top corner of Fig. 9, a speeder gear is provided by which the normal speed of running can be varied through ± 5 per cent.

The steam chest, with its three valves, is illustrated in detail in Figs. 20 and 21, page 221. The valve on the left is a combined stop valve and emergency valve. The main governor valve is shown in the centre and the overload by-pass valve to the right. The governor valves are controlled by oil under a pressure of 60 lb. to 80 lb. per square inch. If the oil pressure fails for any reason, both governor valves close automatically. The valve spindles are ground a good fit to long bushes, no packing being used.

Fig. 22.



Details of the reduction gear are illustrated in Figs. 13 to 16, Plate XXIII. The principal dimensions of the gear relatively to those of the turbine and generator are given in the general elevation and plan, Figs. 5 and 6. The gear was purchased from its makers as a complete unit, and the turbine end bearing had to be made to suit. In the future, however, by arranging matters as indicated in Figs. 17 to 19, Plate XXIII, it will be possible to make some saving in the over-all length reducing the distance between the centre line of the turbine exhaust pipe and that of the gear from 6 ft. 4½ in. to 5 ft. 0½ in.

The pinions have a pitch diameter of 6¼ in., that of the wheels with which they gear being approximately 33¾ in.; the circumferential pitch is 0.9 in. and the helical angle 30 deg. The main wheels have steel rims secured to cast-iron centres, as indicated in Fig. 13. The pinion is of steel throughout and, as shown in Fig. 14, is hollow from end to end. It is driven by a shaft passing through its centre, and fixed only at the far end. This shaft, being long and flexible, accommodates itself readily to the movements of the floating frame. This, as best seen in Figs. 14 and 15, is sup-

ported on three cylinders, which are fed with oil by the ports and passages shown. An enlarged detail, showing how the oil is conveyed to the frame without impeding the freedom of its motion, is given in Fig. 16. This shows a section through both the admission and exhaust passages. The port faces make a scraped fit with the spring-loaded bushes.

Any horizontal swinging of the frame is prevented by struts which will be seen in Fig. 14. These struts, whilst preventing horizontal motion, leave the frame free to tilt in a vertical plane by an amount sufficient to equalise the load passed through each half of the pinion. Axial motion of the whole is possible, because, as shown in Fig. 14, the pistons supporting the frame are not bolted to the casing, but simply rest on plane surfaces, and are thus free to slide.

(To be continued.)

INDUSTRIAL NOTES.

THE Minister of Munitions announces that he has made further Orders under the Munitions of War Acts, 1915 and 1916, under which 161 additional establishments have been declared controlled establishments. The total number of controlled establishments under the Munitions of War Acts is now 4,212.

The Ministry of Munitions forwards the following for publication :—In amplification of the announcement made by the Ministry of Munitions with regard to the rest period for munition workers at the end of September, it should be understood that the stopping and starting times for day and night-shifts will be as follows :—Day-shift stops at 5 p.m. or other usual stopping time on Wednesday, September 27, and resumes at 6 a.m. or other usual starting time on Monday, October 1. Night-shift stops at 6 a.m. or other usual stopping time on Thursday, September 28, and resumes at 5 p.m. or other usual starting time on Monday, October 1.

The President of the Board of Trade has appointed a Committee consisting of Mr. H. Courthorpe-Munroe, K.C. (chairman), Mr. F. W. Goldstone, M.P., and Mr. J. C. A. Ward, to inquire into cases brought before them in which, after appeal to the general manager of the railway company concerned, it is alleged that the instructions regarding the release of railwaymen for active service, issued by the general managers of the British railway companies at the request of the Railway Executive Committee, have not been followed, and to report to the Board of Trade what action, if any, is called for in each case. Mr. G. J. Salmon, 3, Harcourt-buildings, Temple, E.C., will act as secretary to the Committee, and any communications should be addressed to him.

The National City Bank in its last circular on business conditions calls attention, says *The Engineering and Mining Journal*, New York, to the alarming increase in the inefficiency of labour as follows :—

"It is a deplorable fact that there are circumstantial and authentic reports going to show that labour, in some instances, instead of being inspired by higher pay to greater productiveness, is becoming less efficient. In one instance under our observation a large employer, whose attitude toward labour is that of sympathetic consideration, reports that after raising wages three times within a year the output per man is in serious degree less than before. The superintendents in immediate charge of operations attribute these results to indifference, loss of discipline, and to the fact that other jobs can be easily had. It is needless to say that this development is disappointing to all who are sincerely interested in seeing the standard of wages and of living advanced."

It is discouraging to see, adds our contemporary, that the discountenancing of efficiency obtains the sanction of the American people collectively through Acts of Congress, one of which proposes to make it illegal to institute time studies in Government work. The abolition of efficiency systems does not come from the men themselves so much as it does from the walking delegates, who foresee a curtailment of their power, activity and income. There is the underlying desire of human nature to throw thrift to the winds, to live from hand to mouth and to have a good time while the going is good. Therefore, if with present circumstances a man can earn as much in five days as he used to in six, and the income is sufficient, why work more than five days ?

The monthly report of the National Union of Boot and Shoe Operatives states that trade continued exceptionally busy owing to contracts for army boots. The Board of Trade figures for July were as follows :—"Much activity continued in the boot and shoe trade and labour was in great demand. The Russian boot contract employed a large number of the available operatives in most of the principal districts. Returns from firms employing 60,434 workpeople in the week ended July 22 showed practically no change in the number employed and an increase of 1.5 per cent. in the amount of wages paid compared with a month ago. Compared with a year ago there was a decrease of 1.6 per cent. in the number employed, but an increase of 3.4 per cent. in wages paid." Disputes, adds the report, have been very scarce, and those that had occurred had been dealt with either by the local or the national officials and no stoppages had taken place.

"There is presumably some ground for the belief," says *The Textile Mercury*, "that an attempt is afoot to fasten the Labour Exchanges as a millstone around the industrial neck. The belief is at any rate accepted in well-informed quarters in Yorkshire, and the attempt to force these superfluities upon employers and employed is strongly resented. There is little to show any need at all for the continued existence of the exchanges. Certainly they are extraordinarily expensive pieces of machinery, and idle pieces at that. Nothing is done by them that was not done efficiently without them or that could not be again done in their absence. Whether we like it or not we have to pay for the upkeep of these redundant institutions, but hitherto we have at least had the privilege of passing over them in the engagement of employees. If the plot succeeds, this privilege will be lost. Willy-nilly, we shall have to give or take employment through the exchange under penalty of a heavy fine for asserting one's right as a free man to make contracts of service independently. The tyranny is as monstrous a one as has been conceived, and it can be seen that the exchanges are in a desperately bad way when they have to be bolstered in this fashion. Were there any particular good in these institutions they would make their own way in the world, aided as they are by their official status and their lavish subventions. They would acquire a natural monopoly of the labour market; but just because they have not done so, and because there are axes to grind, the attempt is made to force an artificial monopoly upon us. Let it be trusted that Englishmen have not forgotten the right answer to give to this kind of audacity or the right emphasis in giving it."

The forty-eighth Trade Union Congress opened its sittings at the Town Hall, Birmingham, last Monday, under the chairmanship of Mr. H. Gosling. The delegates numbered 663, representing a total of 2,850,547 workpeople. They were welcomed by the Lord Mayor of Birmingham, Alderman Neville Chamberlain. In the course of his speech, after dealing in general terms with the war, Mr. Chamberlain said that the signing of peace was bound to be followed by a period of difficulty. He hoped, however, that something would be done in the way of economic treaties between this country, the Dominions and the Allies to prevent our being exploited by those who had stood aside while the battle for freedom was being waged, and he believed that in regard to plant and machinery employers were better equipped to-day than ever before, but they knew that if they were to maintain their stand against competition they had to get the last ounce out of the plant and machinery. Therefore, in return for shorter hours and higher wages they would want labour to put forth its utmost effort.

Mr. H. Gosling then delivered his presidential address. He stated that much of the credit for an adequate supply of munitions was due to the work of the Right Hon. Arthur Henderson, M.P., who was now Labour Adviser to the Government, but they would not be content until Government had admitted the unanswerable logic of their case in demanding the creation of a Ministry of Labour. They also wanted the State to take over the mines, railways and shipping, and to control the great storage warehouses and granaries. The problems which would have to be solved on the declaration of peace were most serious, and Government should take all the necessary steps in advance by organising the extensive public works of all kinds that must necessarily be undertaken, so as to prevent the occurrence of any widespread or lasting unemployment. He asked whether after the war employers would not agree to put their business on a new footing by admitting the workmen to some participation, not in profits but in control.

After deliberating upon old-age pensions, the Congress considered a resolution calling upon Government to nationalise the railways completely, and at the same time to arrange for the trade unions concerned to have such a share in the management of the railway system as would enable railway workers to have a real voice in the control of the conditions of their life and work. Mr. Havelock Wilson opposed the resolution; he asked whether the railwaymen had reflected upon what State control involved. He asked also whether they had not had sufficient experience of officials; personally, he added, he would rather deal with "the rottenest shipowner" than with a State official.

At Tuesday's meeting reference was first made to the charges which had been put forward at the Bristol Congress last year in regard to hindrance being placed by labour in the way of the output of munitions; it was suggested that the charges in question emanated from "a sinister crowd in the Civil Service—the Labour Exchanges—who had prepared the documents for Mr. Lloyd George." Mr. Havelock Wilson also condemned the Labour Exchanges and spoke against the suggested appointment of a Labour Minister, saying that such a Minister would be "as helpless as a child in the hands of the officials." A card vote was taken on the clause for appointing a Ministry of Labour, when the motion for referring the clause back was defeated practically unanimously.

A report of the Parliamentary Committee was then put forward stating that there had been correspondence with the American Federation of Labour, the latter recommending "the holding of an International Trade Union Congress at the same time and place as the meeting of the plenipotentiaries arranging terms of peace." On a card vote taken after discussion the recommendation was rejected by a majority of two to one, it being deemed impossible to have any dealings with delegates of the enemy nations.

A resolution in favour of the adoption of an eight-hour day, with a view to facilitate the problem of unemployment, was agreed to without discussion.

The Congress met again on Wednesday, when the following resolution, introduced by the Parliamentary Committee, was considered : "Whereas by conversations between the Minister of Munitions, the Right Hon. Lloyd George, M.P., and representatives of organised labour, it was agreed that in all cases where Trade Union rules and customs were relaxed they should be restored after the war, this Congress empowers the Parliamentary Committee to call for the *status quo ante* when peace is declared. And whereas the Munitions Act was passed subject to this solemn ordination, this Congress demands that Government shall insist upon employers, individually and collectively, keeping faith with organised labour, and, further, should there be any betrayal of this trust, the Parliamentary Committee shall call a special Congress and invite those Ministers of State to be present—with a view to their answering questions relevant to the matter—who urged the workers in a time of national peril to forgo rights and privileges which had taken many years of unity and sacrifice to secure."

The above resolution was carried by a large majority after the defeat of an amendment put forward by a member who proposed deleting the latter portion dealing with the presence of Ministers at the special Congress referred to.

A resolution covering the "national organisation of industry, the formation of a Ministry of Labour and Industry, the national control of land, the national ownership of food warehouses, of war munitions manufacture, of mines and railways, and a first claim for the State on the use of shipping," was passed unanimously.

Other resolutions adopted at Wednesday's meeting dealt with the employment of men after demobilisation, with a compulsory week of 48 hours maximum and a minimum wage of 30s., with pensions, education, housing, &c.

COLLEGE CALENDARS.—The syllabus for the Engineering Department of University College, London, for the ensuing academical year, has just been issued. Term commences on October 2, but the examination for the admission of new students will be held on September 26, and application for admission must be made not later than September 20. As the result of this examination, supplemented by further papers, the Goldsmid Scholarship will be awarded. Full particulars can be obtained on application to the Secretary, University College, London.—The new session of the Royal Technical College, Glasgow, commences on October 26. The courses of instruction of special interest to engineers are those in Civil, Mechanical, Electrical and in Mining Engineering, and Naval Architecture. Both day and evening classes are provided, and there are well-equipped laboratories and class-rooms, full particulars of which can be obtained on application to the college.—The City of Bradford Technical College, the new session of which opens on the 11th inst., pays special attention to the needs of the local textile trades, but is also well equipped on the engineering side. This is under the direction of Professor Charnock. By a reciprocal arrangement with the University of Leeds third-year students in the Engineering course may attend the laboratories at Leeds for work on the refrigerator plant, air compression and hydraulic installation.—The new calendar for the South Wales and Monmouthshire School of Mines has just been issued, giving particulars of the regulations and scheme of study to be followed by candidates for the joint diploma in coal mining issued by the University College of South Wales and Monmouthshire in association with the School of Mines at Treforest. This school is well supported by the principal collieries in the district, and is provided with an able teaching staff and well-equipped laboratories. Particulars can be obtained on application to the Secretary, 4, Mount Stuart-square, Cardiff.

DRILLING AND TAPPING MACHINE.

CONSTRUCTED BY THE LANGELIER MANUFACTURING COMPANY, PROVIDENCE, R.I., U.S.A.

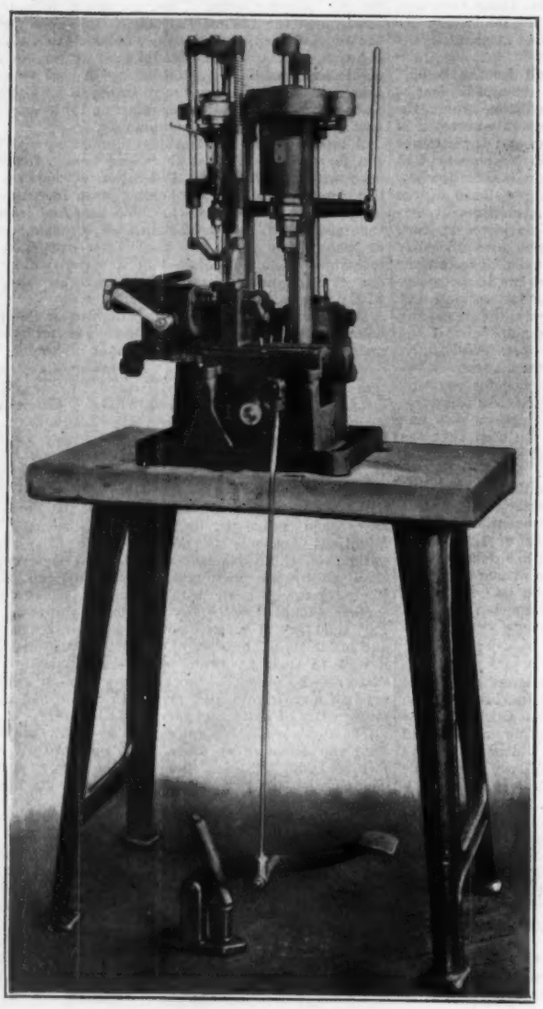


FIG. 1.

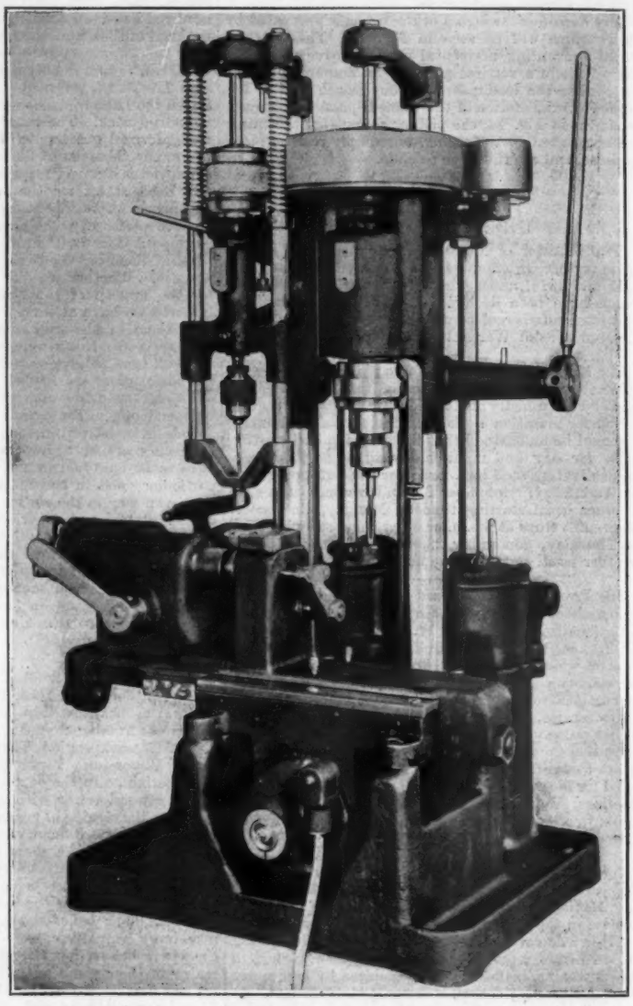


FIG. 2.

THE machine illustrated above is designed to drill and tap a single hole at one setting, or, where an indexing jig is used, several holes in line, radially. While the drilling spindle travels about 5,000 r.p.m., the tapping spindle is reduced to a safe tapping speed. The tapping spindle is equipped with an automatic reversible tapping device, and both spindles are provided with independent stops, having micrometer adjustments.

The top drill runs in a slip bushing, carried by a steady jig; this slip bushing being in alignment with a liner bushing in the jig. When the jig is brought under the tapping spindle this comes in alignment with the drilled hole, so that no bushing is required for the top, this running clear in the liner bushing.

Both spindles are depressed at the same time by one feed lever. The design of the work as, for example, the cap of a fuse, is such that no great pressure is necessary to clamp it during the drilling and tapping operations, so that in this instance a tension spring operating a plunger does very nicely.

As the hole is located a certain distance from the face of the cap, and is required to be at right-angles to two wrench holes on the round nose of the piece, two points of location are used. The plunger is recessed to a fit on the nose, and provided with two locating pins which engage the wrench holes. The face of the work bears against a floor plate having an integral locating plug, this latter centralising the work while it is clamped between the plunger and the floor plate.

An automatic ejector is provided, so that when the plunger is withdrawn at the completion of the tapping operations the work is automatically ejected, the operator therefore being only obliged to load the fresh work.

The ejector consists of two fingers carried by a yoke, as can be easily seen in the illustrations. The clamping plunger, described above, has a rack out in the lower side, this engaging a segment operated by the hand lever shown on the left-hand side of jig. In the shaft carrying the segment a ratchet is cut into which a pawl engages when the plunger is in its extreme forward or clamping position. As the plunger is opened by depressing the hand lever the ratchet carries with it the pawl which, by a connecting rod, operates the yoke shown on right-hand side of jig. Just before the end of the open position is reached the pawl is released and the ejector returns to normal, so that there is no interference in loading.

To operate, the hand-lever on the jig is depressed, bringing the plunger to the open position. The work is inserted at one end into the recessed end of the plunger, and twirled until the pins engage the wrench holes, when the hand-lever is released.

The right hand of the operator drilling the tap size hole depresses the feed lever of the spindles. Withdrawing the spindle and pressing down the foot lever carries the jig under the tapping column, when the tapping operation may be completed. As soon as the tapping spindle is withdrawn the foot lever is released, the operator opens the plunger, ejecting the finished work, and the jig is ready for inserting a new piece by the time it has returned to the first position.

Gibs are provided to compensate for wear, while the steps at either station are adjustable, pneumatic buffers absorbing the shock at the end of the return stroke. The speed of return is also adjustable, an air valve regulating the buffer, while the flat spiral spring operating the return of the carriage is also adjustable for tension.

This machine will be found useful on a great variety of work, as the jigs may be changed to suit any work within its capacity, while taps up to 1/4 in. may be used with safety.

It is made by the Langelier Manufacturing Company, of Providence, R.I., U.S.A.

THE UNITED STATES STEEL CORPORATION.—An extra dividend of 1 per cent. has been declared upon the common shares of the United States Steel Corporation. The balance available for dividend for the quarter ending June 30 was 65,706,260 dols., as compared with 14,572,564l. in the corresponding period of 1915. Hence the welcome special 1 per cent. now proposed to be distributed, and which represents a payment of 5,083,025 dols. Not only has the extra dividend been fully provided for out of increased profits, but the surplus carried forward at the close of June was 47,964,535 dols., as compared with 8,267,645 dols. at the close of June, 1915. The profit earned upon the company's 508,302,500 dols. of outstanding common stock for the quarter ended June 30 was at the extraordinary rate of 64½ per cent. per annum. The net earnings for the first half of this year were :—January, 18,794,912 dols. ; February, 19,196,396 dols. ; March, 22,722,316 dols. ; April, 25,423,676 dols. ; May, 27,554,879 dols. ; and June, 28,147,473 dols. ; making an aggregate of 141,839,652 dols. The unfilled orders on hand at the close of June this year amounted to 9,640,458 tons, which will keep the plant fully occupied for several months. Further new business is also stated to be coming in at a satisfactory rate.

THE MATHEWS GRAVITY CARRIERS.

CONSTRUCTED BY MESSRS. W. AND C. PANTIN, ENGINEERS, LONDON.

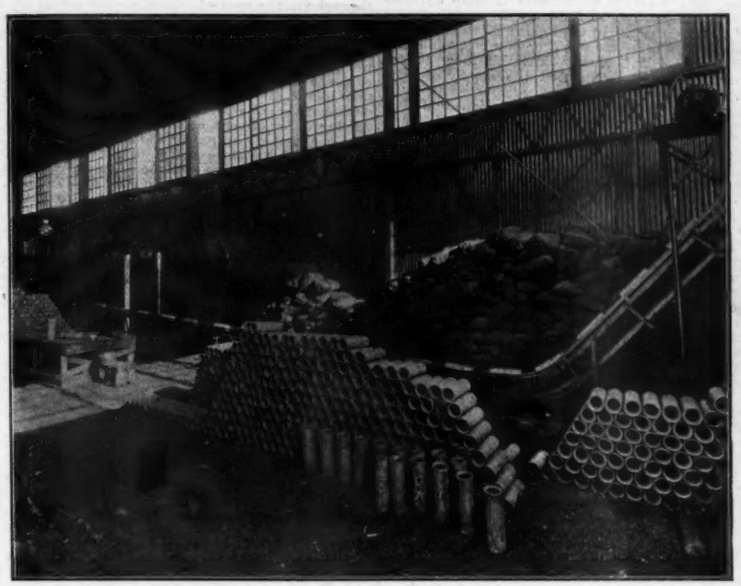


FIG. 1.

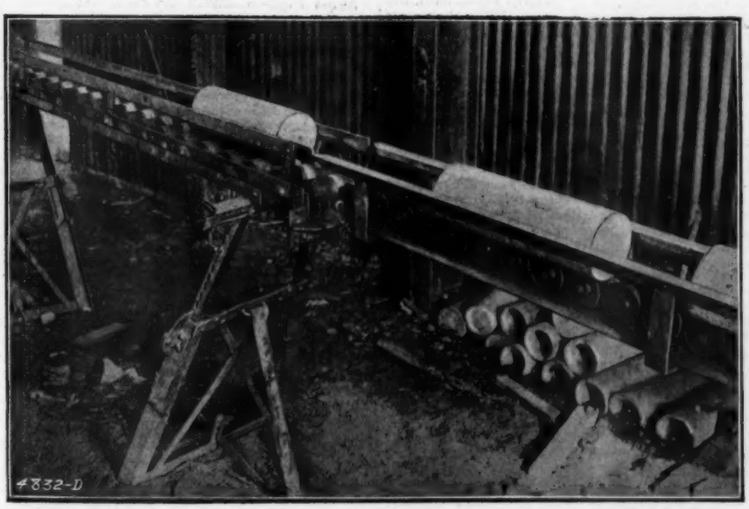


FIG. 2.

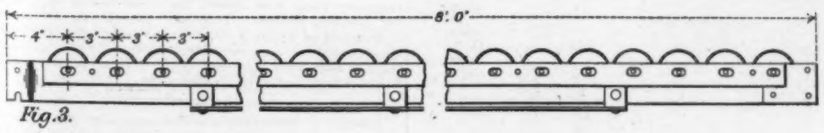


Fig.3.

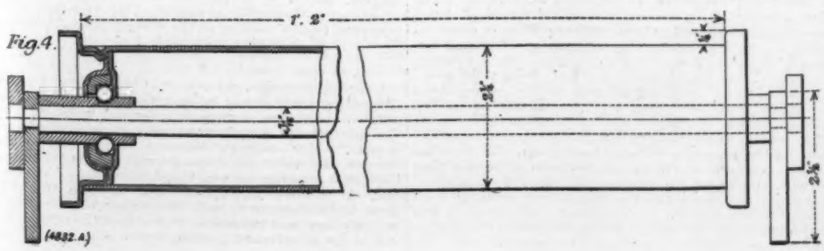
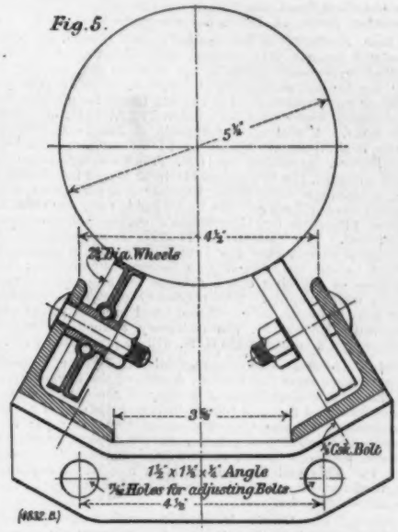


Fig.4.

Fig.5.



THE MATHEWS GRAVITY CARRIERS.

WE illustrate in Figs. 1 to 5 on the present page an elevator and a gravity carrying device constructed by Messrs. W. and C. Pantin, 147, Upper Thames-street, E.C. The elevator consists of a lattice frame carrying a wrought-iron track, the elevator proper consisting of a continuous chain with slats 3½ in. by ⅝ in., having a flanged roller on each, running along the iron inclined guides and forming a continuous apron, provided with claws to prevent the material transported from falling sideways. The elevator, a portion of which is seen in the view Fig. 1, is designed for the transporting of shells or shell billets; it is operated by an electric motor, the power of which depends upon the height of lift, the weight of the billets to be dealt with and the travelling speed. The elevator is fed automatically by, or, as the case may be, delivers upon, a gravity carrier shown in Figs. 2 to 4. The carrier is built up in sections, each section consisting of a frame 8 ft. in length and very similar in general construction to the sections of a contractor's narrow-gauge portable railway. The sections are connected together by a hook joint, shown on the left-hand side of Fig. 3. The rollers, one of which is illustrated in Fig. 4, are built up of solid drawn steel tubes with roller bearings. The type shown in Fig. 4 is the one supplied for special purposes, such as the carriage by gravity of petrol cans, barrels, &c. Its length is 1 ft. 2 in. between the flanges. The standard length of rollers for billets and shells is 8 in., these rollers having no flanges. The rollers are easily inserted into the frames, and these, when built up complete, are supported on trestles provided with means to make up for any unevenness in the ground level and to insure a gentle gradient towards the place of delivery. A main gravity carrying line, connected by curved sections having taper rollers with secondary gravity lines at right angles with it, is built to deal with the distribution over a factory of shells in various degrees of completion. Fig. 5 shows another type of gravity carrier which Messrs. Pantin build for circular billets or partly turned shells; this consists of wheels 2¾ in. in diameter, formed of stampings, revolving on ball bearings and carried in angle brackets.

CANADIAN CARS FOR RUSSIA.—A first order for 7,000 box cars has been placed at Ottawa by the Imperial Munitions Board on account of the Russian Government. The order has been divided chiefly between the Canadian Car and Foundry Company and the National Steel Car Company. Altogether contracts are likely to be let for as many as 50,000 cars.

MANGANESE ORE AT ILSEDE.—Much of the manganese ore wanted for the German steel industry now comes from the Ilsederhütte, near Peine, east of Hanover. The occurrence of manganese ores was known, but the ores were practically inaccessible, lying immediately underneath the village of Ilsede. A large portion of this village had to be removed; this has been done since the war began, and the works are said to have paid 33 per cent. in dividends last year. The district of Peine also produces petroleum, and there is a petroleum refinery at Peine.

COLONIAL AND FOREIGN ENGINEERING PROJECTS.

We give below a few data on several Colonial and foreign engineering projects taken from the *Board of Trade Journal*. Fuller information on these projects can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, London, E.C.

New Zealand.—H.M. Trade Commissioner in New Zealand reports that tenders will be received by the Gisborne Borough Council, up to noon on October 2, for the supply, delivery and erection, at the municipal electric power station, of a cooling tower for cooling the circulating water used for condensing 9,000 lb. of steam per hour. A preliminary deposit of 20*l.* must accompany each tender. According to an extract from the local press, forwarded by H.M. Trade Commissioner in New Zealand, the Wanganui Harbour Board has decided to complete a deep water harbour scheme which will enable the berthage of eight liners inside the river mouth. Plans prepared by the Board's engineer have been approved. The Imperial Trade Correspondent at Dunedin reports that the Dunedin City Corporation is about to ask for authority to borrow 140,000*l.* for the purpose of carrying out a scheme for augmenting the city's water supply. The necessary pipes and fittings will not, however, be purchased until pre-war prices are restored. Meanwhile, the necessary tunnelling, which will occupy a considerable time, will be proceeded with.

South Africa.—The Commercial Intelligence Branch is in receipt, from the London Agents of the Corporation of the City of Capetown, of a copy of the specification, conditions and form of tender in connection with a call for tenders by the Corporation of Capetown for the supply and delivery of pumps, motors, piping, overhead cranes, penstock gates, screens, valves, &c. (contract No. 1). This call for tenders is in respect of supplies required for the scheme for the disposal of sewage in the Capetown suburbs.

Spain.—The *Gaceta de Madrid* notifies that tenders will be opened at the "Dirección General de Obras Públicas, Ministerio de Fomento," Madrid, on September 16, for the clearing away of rocks in the river channel of Bilbao. The estimated value of the contract is 1,981,221 pesetas (about 84,300*l.* at current rate of exchange). Work must be commenced within a period of two months from the date of the award of the contract and completed within five years. The *Gaceta* also contains a call for tenders by the Madrid Corporation for the extension of a school building in that city at an estimated cost of 78,449 pesetas (about 3,300*l.* at current rate of exchange). Tenders will be received at the "Casa Consistorial, Plaza de la Villa, 4," Madrid, up to September 18.

Argentina.—The *Boletín Oficial* (Buenos Ayres) contains a Decree approving a project for the extension of the National Prison at Buenos Ayres at an estimated cost of 867,756 pesos currency (about 75,900*l.*). The *Boletín* also publishes a Decree approving the expenditure (as soon as funds for the purpose may be available) of 67,050 pesos currency (about 5,900*l.*) on the construction of works necessary to prevent the overflowing of the Rio Negro at the town of Conesa, Territory of Rio Negro. The *Boletín* further publishes a Decree authorising the Argentine Irrigation Department to carry out investigations and draw up a scheme of works for the development of irrigation in the Department of Metán, Province of Salta, by the extended utilisation of the waters of the rivers Concha, Metán and Yatasto.

Imports into France and Algeria.—In agreement with the British Government, the French Government has set up at King's House, Kingsway, London, W.C., a special office for the issue of licences for the importation into France and Algeria of goods of British production or manufacture which are included in the list of articles prohibited to be imported into those countries. The following procedure has been laid down for the working of this service:—The application for a licence must be drawn up strictly in accordance with the form provided, and include a certificate to the effect that the place of production or manufacture of the goods is situate within the British Empire, that is to say, either in the United Kingdom or in a British Dominion, Colony or Protectorate. This certificate (which is inserted on the form of application itself) must be signed on behalf of the Chamber of Commerce of the district or town in which the merchant concerned carries on his business. The form should then be forwarded by the applicant to the Board of Trade, Gwydyr House, London, S.W., which Department, after examining the application, will "viser" the same and forward it to the French office in London. On receipt of this document, the French office will, unless there are reasons to the contrary, issue an import licence, which will be despatched in original to the actual consignee of the goods in France, and of which a copy will be addressed to the exporter in this country. In order to prevent delays and difficulties, applicants for licences are specially recommended: (1) To draw up their applications in as precise a form as possible, as regards the number and description of the packages, the marks and numbers thereon, the description of the goods, and the quantities to be exported. (2) To specify on the application, in a legible manner, the name and address of the consignee and the port of discharge in France or Algeria; and to furnish the description of the goods in both French and English. The French office in London will not grant licences for the import into France or Algeria of diamonds, woods and metals, and those parts or accessories of automobiles of which the importation into France is prohibited. In these cases applications for import licences should be made by the consignee to the competent authorities in France.

ELECTRIC UNDERTAKINGS IN JAPAN.

A statistical report of electric undertakings in Japan, recently issued by the Department of Communications, states that the first electric undertaking in Japan was only directed towards the supply of electric lights in Tokyo, by the Tokyo Electric Light Company, in November, 1887, with one home-made 75-lamp dynamo (afterwards replaced by two 200-lamp Edison dynamos) installed at Nihonbashi. In the following year the company constructed three more power stations, while the Kobe Electric Light Company installed four 20-kw. Edison dynamos and commenced the supply of light in Kobe.

The aggregate capacity of generating stations in Japan at the end of 1888 came to about 500 kw. In May, 1889, the Osaka Light Company adopted the high-tension alternating-current system for the first time and opened its business in Osaka with one 30-kw. dynamo (1,040 volts) of the Thomson-Houston type. In the following year an electric light supply business was started in Kyoto, Nagoya and Yokohama, and thus the total capacity of generating stations reached 1,500 kw. at the end of 1890. Thereafter the electric business made steady progress, and the first electric traction undertaking in Japan was the electric tramway which was opened in Kyoto in 1895.

The electric undertakings in Japan continued to increase in importance, and in due course the question of transmitting power to a long distance was taken into consideration. As a result, in 1899 an enterprise was opened in the town of Koriyama for the transmission of electric power over a distance of 15 miles at a pressure of 10,000 volts, the electric capacity concerned being 300 kw. This undertaking having proved a success, the voltage was further enhanced and the distance of transmission extended. Towards the end of 1907 the Tokyo Electric Company established a hydro-electric power-station at Komahashi, Yamanashi Prefecture, the capacity of which is 15,000 kw., transmitting that power to Tokyo over a distance of 50 miles, to supply electric lights in Tokyo at an extra-high tension of 55,000 volts. In view of this successful undertaking of the Tokyo Electric Light Company similar undertakings have been contemplated at various places, availing themselves of the water-power abundant in the country. Among those undertakings the enterprise of the Inawashiro Hydro-Electric Company is the largest one ever established in Japan. In October, 1914, the company completed the work of the first hydro-electric generating station in the neighbourhood of the Lake Inawashiro, the capacity of which is 14,000 kw., transmitting the power to Tokyo over a distance of 140 miles at an extra-high tension of 115,000 volts.

At the present time electric undertakings in Japan are showing a rapidly progressive tendency; at the end of 1913 the total capacity of generating stations (exclusive of those under construction) amounted to 503,541 kw. The length of tracks having electric traction reached 701 miles at the end of 1913, whereas it was only 72 miles at the end of 1903. In 1910 the Hydraulic Power Investigation Bureau, which was continued to 1913, was organised for the purpose of investigating hydraulic power to be utilised for generating electric power. The available hydraulic power in Japan is estimated by the said bureau at about 2,300,000 horse-power.

New American Anti-Aircraft Guns.—According to *Aviation* a new journal devoted to aeronautical matters, of which the first number was published in New York last month, the United States battleships Texas, Pennsylvania and Nevada, of the Atlantic Fleet, are being equipped with new anti-aircraft guns of exceptional range. These guns have been developed through experiments conducted by the Bureau of Ordnance during the last three years under the direction of Rear-Admiral Strauss, and special credit for the design is given to R. G. Marvell, Commander A. L. Norton (retired) and Commander C. B. McVay. The guns are 3-in. bore and 50 calibres long, and it is claimed that they have a vertical range of 27,000 ft.

War Taxes in Norway.—The Norwegian Government, says the *Anglo-Norwegian Trade Journal*, has imposed the subjoined war taxes on shipping profits for 1916–17 to meet the extraordinary internal expenses caused by the war:—

		Kroner.
5 per cent.	on the first	5,000
7½ ,,	on the next	10,000
10 ,,	,, ...	15,000
12½ ,,	,, ...	20,000
15 ,,	,, ...	25,000
17½ ,,	,, ...	30,000
20 ,,	,, ...	on any excess profit.

(1 kr. = 1*s.* 1½*d.*)

The Institution of Automobile Engineers.—The first meeting of the session of the Institution of Automobile Engineers will be held on Wednesday, October 11, 1916, in the Hall of the Royal Society of Arts, John-street, Adelphi, W.C., at 8 p.m., when the President, Mr. L. A. Legros, M.Inst.C.E., will deliver his presidential address. The address will contain, among other things, a valuable collection of data in reference to torque curves of internal combustion engines. Cards of invitation to the meeting may be obtained on application to the secretary of the institution, 28, Victoria-street, Westminster, S.W. It is hoped that this year it will be possible to arrange for the full number of meetings, but meantime the institution is engaged on much important work in connection with research and standardisation, the results of which should be available for the members before the end of the session.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Glasgow Pig-iron Market.—Business is still suspended in the Glasgow pig-iron warrant market, while the stocks in store remain much as they did a week ago.

Scotch Steel Trade.—Conditions in the steel trade throughout the west of Scotland continue much on the same lines as last week. Except in cases where a complete overhaul of the machinery has been rendered necessary by the heavy strain of the past year or so, the greatest activity still prevails, and there is every evidence that in the months to come this will be well maintained, the many Government contracts at present on hand being sufficient to keep the works busily employed for a very considerable period. It is confidently expected that, after the necessary repairs to the machinery have been completed, a very considerable increase in production will be effected, a condition of affairs much desired by the Ministry of Munitions, for at all costs the output must be kept up to the required standard. While ordinary mercantile export is particularly dull, large and important shipments of war material are being made to the various Allies, Italy and Russia at the moment being heavy consumers. In consequence the question of delivery is again cropping up, manufacturers finding the greatest difficulty in meeting their customers in this respect. Government restrictions, of course, have put an end for the time being to preferential orders, otherwise there might be a solution with premium prices which would be willingly paid. All over, prices are firm, and the general position strong, and it is being more fully realised every day that nothing must come in the way of the output of finished material for war purposes. For steel ship plates the quotations still run from 15*l.* per ton upwards; boiler plates, 16*l.*; and angles, 14*l.* 5*s.* or thereabouts.

Malleable Iron Trade.—If anything, the boom in the malleable iron trade is on the increase. Government and many other buyers, despairing of having all their demands met by the steelmakers, who cannot possibly guarantee delivery by a specified date, are now turning their attention to iron instead. This has considerably added to the pressure in the various producing works where the labour problem is still of vital importance. Directly or indirectly, everything turned out is on Government account. "Crown" bars are still quoted as a week ago—14*l.* 12*s.* 6*d.* per ton, less 5 per cent. for the home market, and 14*l.* 5*s.* and up for export.

Scotch Pig-iron.—With the continued scarcity of raw material it seems almost impossible to satisfy the demands made by our own Government and those of the Allies for the requisite supplies of all grades of pig-iron, and under these circumstances it is only natural that none is being disposed of for other than war purposes. In the Glasgow market, for instance, no hematite can be obtained otherwise, and with the scarcity of foundry grades also, and particularly No. 1, the position is certainly rather strained. Prices keep firm.

Shipbuilding in August.—While the output of mercantile shipping for August is low, compared with what it was in pre-war years, it is considerably in advance of the totals either for August of 1914 or of 1915, while the tonnage is the second highest recorded for any month this year. On the Clyde, the tonnage was 19,000 tons for three vessels, the only other river which launched anything being the Dee. During the eight months just ended there have been launched on the Clyde 30 vessels with a gross tonnage of 93,785 tons, as against 57 vessels of 170,268 tons in the corresponding period of last year. No Government work is included in any of these figures, so that it is quite apparent that, despite the rumours current some little time ago with regard to mercantile shipping, no increase of output has yet been obtained. While all the yards are fully employed, no new contracts fall to be noted during August. The following table gives the figures on the four principal rivers from January till the end of last month:—

Clyde.	Forth.	Tay.	Dee.
Vs. Tons.	Vs. Tons.	Vs. Tons.	Vs. Tons.
30 93,785	9 5,709	3 7,950	17 3,322

Interesting Launch at Alloa.—On Friday, the Forth Shipbuilding and Engineering Company, Limited, the new firm which recently took over the shipyard in Alloa formerly owned and worked by Messrs. Mackay Bros., launched their first vessel, the Countess of Mar, built for London owners. This new steamer is 285 ft. in length and of about 3,800 tons carrying capacity, being constructed for a general cargo trade. Triple-expansion engines have been supplied by the North-Eastern Marine Engineering Company, Wallsend-on-Tyne.

American Petroleum.—The quantity of petroleum marketed in the United States in 1915 was 281,104,104 barrels, valued at 179,462,890 dols. There was more American crude petroleum marketed last year than in any previous twelve months in the history of the industry. The increase over 1914 was nearly 6 per cent.

German Shipping after the War.—The German shipping journal *Hansa*, in reviewing the chances of the different countries as regards merchant shipping after the war, admits that Germany will be seriously handicapped. Her shipping has not reaped any golden harvest, and whilst the ships of almost all other countries have kept crossing the sea, the German ships have been idle. It is, however, expected that the German Parliament will endeavour to help the German merchant navy in every way, and the sooner this is done the more active will be the initiative of German shipowners.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—Export restrictions are responsible for a falling off in the despatch of manufacturing fuel, considerable difficulties being experienced in this section of trade owing to the lack of transport and the commandeering of supplies. The requirements of neutrals are heavy, but reserves are limited. Best steams are in strong request, especially on railway account, the companies endeavouring to lay in stocks and make their position secure against the coming winter. Last season stocks ran very short, and at one period several of the companies were living practically from hand to mouth. Heavy tonnages are going into works, the pits, with their reduced staffs, being kept at full stretch to cope with the demand. Cobbles and nuts are being much sought after by factories in all parts of the country, and the collieries have little, if any, stock on hand. Slacks are somewhat firmer than a fortnight ago, with every appearance of returning to their former strong position. A considerable tonnage has accumulated in view of anticipated arrangements for export to Italy. Cokes are scarce, and making top prices. So far as house qualities are concerned, the demand keeps well above the average. A considerable amount of stacking is going on for winter use, and the demand of the gas companies is exceptionally brisk. The whole of the output is readily absorbed. Quotations: Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best Silkstone, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire best Brights, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire house, 16*s.* to 17*s.*; best large nuts, 15*s.* 6*d.* to 16*s.* 6*d.*; small nuts, 15*s.* to 16*s.*; Yorkshire hards, 16*s.* 6*d.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; smalls, 8*s.* to 9*s.* per ton.

Iron and Steel.—Large steel firms in Sheffield are now in the excellent position of being able to accept or turn down orders of such a capacity as would have created a boom in ordinary times. Manufacturers, however, are not able to cope with many new orders as they are already in arrears in delivery of all kinds of tools, cutlery, &c., orders for which are rapidly accumulating. The market for common irons is still in an unsettled condition, and a position has arisen with regard to Derbyshire brands which has brought buying nearly to a standstill. Although the latter were not quoted in the official list issued by the Ministry of Munitions last week, they claim they are entitled to the extra 5*s.* advance. The official announcement makes no mention of Derbyshire, Leicester or Notts. irons; while according to notification the price of Staffordshire, Lincolnshire and Northamptonshire pig has been advanced 5*s.* to 92*s.* 6*d.* at furnaces, the other three makes still remain at 87*s.* 6*d.* Mixed hematites are scarce, but fewer complaints are being made as to deliveries of special brands. Steel making irons are still consumed in very large quantities. Commercial users are unable to procure adequate supplies of basic billets, but in due course it will be seen whether the Government's appeal to change foundry furnaces into basic iron, meets with a satisfactory response. Makers of special acid billets are not forbidden by regulation to quote prices which they deem reasonable for their products, but acid makers generally consider the Government maximum to be ridiculously low. The supply of female labour for munitions is in excess of the demand, and large numbers are now on the Labour Exchange books. Files have come under the export restrictions, and special licenses have to be obtained before sending these tools away. The War Trade Department have found it necessary to issue this embargo in order to ensure a larger supply for home use. The employment of women in this branch of industry has not greatly increased output as they are only capable of making the smaller class of file. A similar prohibition has been made with regard to the merchanting of small tools, twist drills, milling cutters, reamers, boring tools, &c., which means still more delay in executing business for overseas. Before this order was issued a considerable export business in this class of tools was done on certificates obtained from the Sheffield Cutlers' Company. The overseas business generally is well maintained, notwithstanding these obstacles. New orders include files, cutlery, springs, tools (for New York and Melbourne), steel pedestals, electro-plate, steel (for Montreal, Toronto and Capetown), saws, sheep shears, and machetes.

TUTICORIN.—The Government of Madras has approved provisionally a scheme formulated by the Tuticorin Port Conservancy Board for providing Tuticorin with a deep-sea harbour. Orders have been given for taking preliminary borings in order to ascertain the nature of the bottom at various points. A party of boring experts furnished by the Public Works Department will shortly arrive at Tuticorin to commence operations.

CHAIR OF ENGINEERING FOR ABERDEEN UNIVERSITY.—By the death of Mrs. William Jackson, widow of Mr. William Jackson, Thorngrove, Aberdeen, which occurred on the 1st inst., several substantial legacies fall to charities in Aberdeen, while a large sum will also become available for the establishment of a Chair of Engineering at Aberdeen University. These important bequests were left for the purposes specified in Mr. Jackson's will subject to a life-rent to his widow, now dead. Mr. Jackson had a great foreign and Colonial reputation as an inventor and manufacturer of improved machinery required in connection with the tea and coffee-planting industry, and part of his estate is to be devoted to the assistance of the wives and families of tea planters in India.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—There is a quieter feeling as regards Cleveland pig-iron. With all legitimate home needs assured by the allocation of supplies by the Distributing Committee, and the fact that there is some surplus for shipment to our Allies, consumers are not particularly pressing their demands. A fair number of orders from Scotland for this month's delivery continue to come forward. Deliveries to France are on a good scale, and licences for shipment to Russia via Norway are being obtained, but the numerous inquiries on behalf of neutral countries do not lead to business. For home consumption No. 3 Cleveland pig, No. 4 foundry, and No. 4 forge all stand at 87*s.* 6*d.*, and No. 1 is quoted 91*s.* 6*d.*; whilst for export No. 3 is 97*s.* 6*d.*; No. 4 foundry, 96*s.* 6*d.*; No. 4 forge, 95*s.* 6*d.*; and No. 1 is in the neighbourhood of 102*s.* 6*d.* It is stated, however, that No. 3 is purchasable from makers at 95*s.* for shipment to France, and, on the other hand, any warrant iron that comes on the market for prompt shipment is eagerly taken up at 100*s.*

Hematite Iron.—Opportunity for transaction of new business in East Coast hematite is small, but deliveries on running contracts are understood to be well maintained. Stocks are practically nil, and producers are sold to the end of the year. For home use and for shipment to France Nos. 1, 2 and 3 are put at 122*s.* 6*d.*, and for general export the quotation is 140*s.* and upward.

Output of Pig-iron.—Preparations are practically complete for the re-starting of a few blast-furnaces, and the output is expected to be increased during the month by putting into operation additional plant. There are at present blowing on the North-East Coast 71 blast-furnaces, of which 30 are producing hematite, 28 are turning out Cleveland pig, and 13 are manufacturing basic, spiegel and other special irons.

Stocks of Cleveland Pig-iron.—The stocks of Cleveland pir-iron in the public warrant stores here have been reduced to 15,484 tons, composed of 15,448 tons of No. 3 quality, and 36 tons of other descriptions of iron deliverable as standard. Since the beginning of the month 201 tons of No. 3 and 350 tons of standard iron, a total of 551 tons, have been withdrawn from the stores.

Coke.—The rather heavy local demand for coke is met by a very ample supply, the curtailment of shipments having left considerable additional quantities available for home needs. Quotations are unaltered. Average blast-furnace coke is 28*s.* at the ovens, and up to 30*s.* 6*d.* at the ovens is still asked for qualities low in phosphorus.

Foreign Ore.—Consumers of foreign ore are heavily bought, and have large and steadily accumulating stocks, with the result that they are not in the market to buy, and business is practically at a standstill. Imports to Middlesbrough so far this month amount to 39,729 tons. Though there is little or nothing doing, sellers show no signs of weakness, and on the basis of the official 17*s.* freight Bilbao-Middlesbrough, Rubio of 50 per cent. quality remains at 38*s.* ex-ship Tees.

Manufactured Iron and Steel.—Government work still absorbs the attention of finished iron and steel manufacturers, and the rather numerous ordinary commercial inquiries attract little notice. Prices all round are very strong, and packing iron and steel have been advanced by 20*s.* The following are among the principal market quotations: Common iron bars, 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 17*l.* 10*s.* to 18*l.* 10*s.*; packing iron and steel (parallel), 11*l.*; packing iron and steel (tapered), 13*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.*; steel joists, 11*l.* 2*s.* 6*d.*; heavy steel rails, 10*l.* 17*s.* 6*d.*; and steel railway sleepers, 12*l.* 5*s.*

Iron and Steel Shipments.—Shipments of iron and steel from the port of Middlesbrough during August were quite up to expectations. Those of pig-iron amounted to 63,635 tons, as compared with 54,311 tons for the previous month, and 43,098 tons for August last year. Of the clearances last month 61,570 tons went abroad and 2,065 tons went coastwise. France was by far the heaviest receiver, taking 54,180 tons, the next best customer being the United States, with an import of 3,275 tons. Manufactured iron shipped in August reached only 3,056 tons, 1,801 tons going foreign and 1,255 tons coastwise, and the steel despatched amounted to 28,747 tons, of which 27,498 tons went abroad and 1,249 tons went to coastwise customers. The largest receiver of manufactured iron was the Straits Settlements, with 589 tons, and France, with an import of 22,990 tons, was much the biggest customer for steel, Japan being second with only 1,348 tons.

NOTES FROM THE SOUTH-WEST.

Cardiff.—Little effort has been made to enter into new transactions in Welsh steam coal. In consequence of heavy Government requirements there has been continued difficulty in obtaining supplies of any description of large coal; and until the authorities relax their demands there is little prospect of the situation becoming easier for other purchasers. Fixtures have been adversely affected by the delay which has taken place in the completion of the limitation of prices and freights scheme for Italy. The best Admiralty large steam coal has been to some extent nominal; secondary qualities have made 43*s.* to 44*s.*; Monmouthshire Black Veins, 43*s.* 6*d.* to 44*s.*; ordinary Western Valleys, 43*s.* to 43*s.* 6*d.*; Eastern Valleys, 40*s.* to 42*s.* 6*d.*; best bunker smalls, 30*s.* to 31*s.*; and cargo smalls, 20*s.* to 25*s.* per ton. In bituminous coal, best households have made 25*s.* 6*d.* to 26*s.* 6*d.* at the pits; No. 3 Rhondda, large, 37*s.* to 38*s.*; smalls, 29*s.* to 31*s.*; No. 2 Rhondda, large, 34*s.* to 36*s.*; and No. 2 smalls, 25*s.* to 26*s.* per ton. The latest quotation for patent fuel has been 45*s.* to 50*s.* per ton. Special foundry coke for export has brought 62*s.* 6*d.* to 65*s.* per ton; good foundry coke, 60*s.* to 62*s.* 6*d.*; and furnace coke, 50*s.* to 55*s.* per ton.

Western Trade Matters.—The directors of the Penrikyber Navigation Colliery Company, Limited, have paid an interim dividend at the rate of 15 per cent. per annum for the half-year ending June 30; the corresponding interim dividend 12 months since was at the rate of 10 per cent. per annum.—The sale at a profit of the interest of D. Davis and Sons, Limited, in John Lancaster and Co., Limited, has now been carried through, and the Welsh Navigation Company being now in the happy position of earning profits, the cash resources of the Davis Company have been greatly strengthened, and the directors do not consider that there is any longer a necessity for reserves created to meet previous losses The directors of the Davis Company propose to split its 1*l.* shares into 5*s.* shares.—The directors of Locket's Merthyr Collieries (1894), Limited, recommend the following dividends: On first preference shares at the rate of 6 per cent. per annum, and on second preference shares and ordinary shares at the rate of 10 per cent. per annum.—The accounts of the Fishguard and Rosslare Railway and Harbour Company for the half-year ending June 30 show a balance of 34,253*l.*, which has been applied to the payment of interest on debenture and preference stocks.—In connection with price limitation on coal shipments to France, it has been agreed, at the request of French authorities that the maximum freight of steamers under 300 tons gross register and for sailing vessels shall be 3*s.* per ton above the schedule rate for steamers above 1,000 tons, and it has been also decided, subject to the approval of the French authorities, that freight from Firth of Forth ports shall be increased 2*s.* per ton upon the present schedule.—The price offered to the shareholders of the London and Northern Steamship Company, Limited, for the proposed sale of the business to Messrs. Pyman, Watson and Co., will allow of the repayment of ordinary shares at 46*l.* per share premium—that is, a holder of a 10*l.* ordinary share will be paid off at 56*l.* per share. The directors of the London and Northern Company are also to receive 2,000*l.* cash as compensation for their loss of office.—Reference was made at the last meeting of the Cardiff Chamber of Commerce to Government proposals for a limitation of prices for coal and rates of freight for French Mediterranean ports and Italy. Mr. R. O. Sanderson pointed out that Cardiff shipowners had suggested a standard of 20*s.* per ton to Rouen, upon which freights for all French Bay ports could be based; but, he said, the Board of Trade had itself raised the basis to 24*s.* 6*d.* per ton to Rouen, because it felt that neutral shipping would not take 20*s.* per ton and would go elsewhere.—At the half-yearly meeting of the Milford Docks Company it was announced that the tonnage of vessels entering the docks in the past half-year had been 468,120 tons gross, and 201,174 tons net, as against 483,895 tons gross and 199,169 tons net in the corresponding half of 1915. The directors have been successful in their policy in avoiding the construction of new dock gates, the engineer and manager reporting that the former gates had been restored and might now be regarded as stronger than ever.—Lord Rhondda presided at the annual meeting of the Fernhill Collieries Company, Limited, and stated that the company was growing in strength; the profits for the past year amounted to 44,474*l.*, as against 31,685*l.*; the company was not only doing well, but its prospects were also excellent. A dividend of 10 per cent. upon the ordinary shares was approved.—Mr. T. J. Williams, manager of the Lancaster Steam Coal Collieries, Limited, Cwmtillery, has been appointed agent of the collieries upon the retirement of Mr. W. Thomas. In 1898 Mr. Williams was appointed manager of the Cardiff Navigation Colliery, Llantyisant; he is 51 years of age.—Sir W. Pickford, as independent chairman of the South Wales Conciliation Board, has given his casting vote against an application of the coal owners for a reduction of 15 per cent. in miners' wages. Sir W. Pickford has also vetoed an application of the workmen for an advance of 12½ per cent. The present rate of wages will therefore remain unchanged until December 1.—Warrants for an interim dividend of 6 per cent. were issued on Saturday to the ordinary shareholders in the Consolidated Cambrian, Limited.—Messrs. S. Instone and Co., Limited, shipowners and coal exporters, Cardiff and London, have purchased the Alexandra steamship from Messrs. Taylor and Sanderson for 105,000*l.* The Alexandra, which is 6,100 tons deadweight, was built in 1905. Messrs. Instone are reported to be negotiating for the purchase of other steamers.—The New York City, steamer, of the Bristol City Line, was sunk 12 months since by a German submarine; her successor, which has a carrying capacity of 4,000 tons, was launched on Friday.

BRAZILIAN MANGANESE.—The exports of manganese ore from Brazil last year were 288,671 tons, as compared with 183,630 tons in 1914, and 122,300 tons in 1913. The value of these exports was 2,632,427 dols., 1,380,465 dols. and 880,572 dols. respectively. Since the establishment of the United States Steel Corporation steamship line between the United States and Brazil trade in manganese ore has greatly increased. The line, it appears, has not only solved the problem of securing return cargoes, but it has also built up a substantial trade for the State of Minas Geraes.

THE WELFARE OF MUNITION WORKERS.

(*For Description, see Page* 217.)

Fig. 9. Exterior View of one of the Canteens.

Fig. 10. Interior of Women Workers' Canteen.

Fig. 11. Interior of Men Workers' Canteen.

Fig. 12. View in Kitchen of Catering Department.

Fig. 13. A View in the Laundry.

Fig. 14. The Ironing Room of the Laundry.

1500-KW. GEARED TURBO-GENERATOR AT THE WESTINGHOUSE WORKS, MANCHESTER.

CONSTRUCTED BY THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED, MANCHESTER.

(For Description, see Page 222.)

Fig. 9.

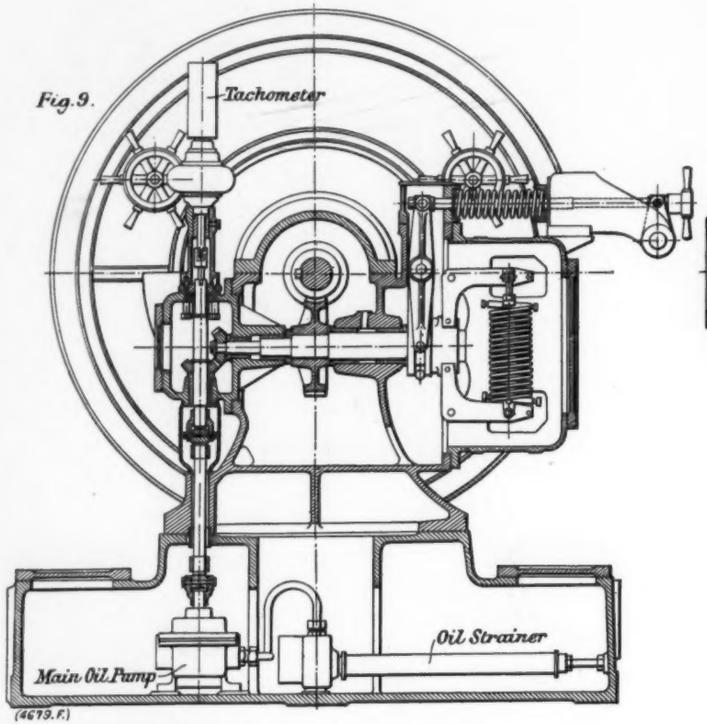


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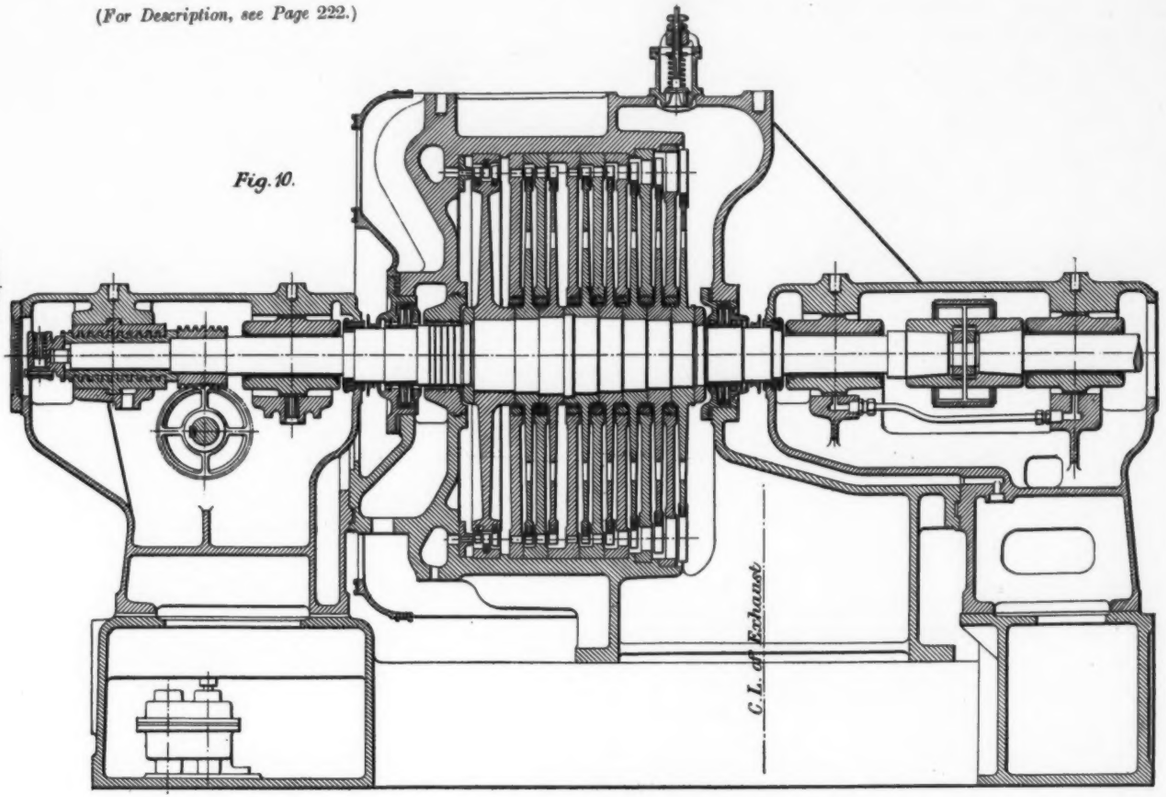
Fig. 10.



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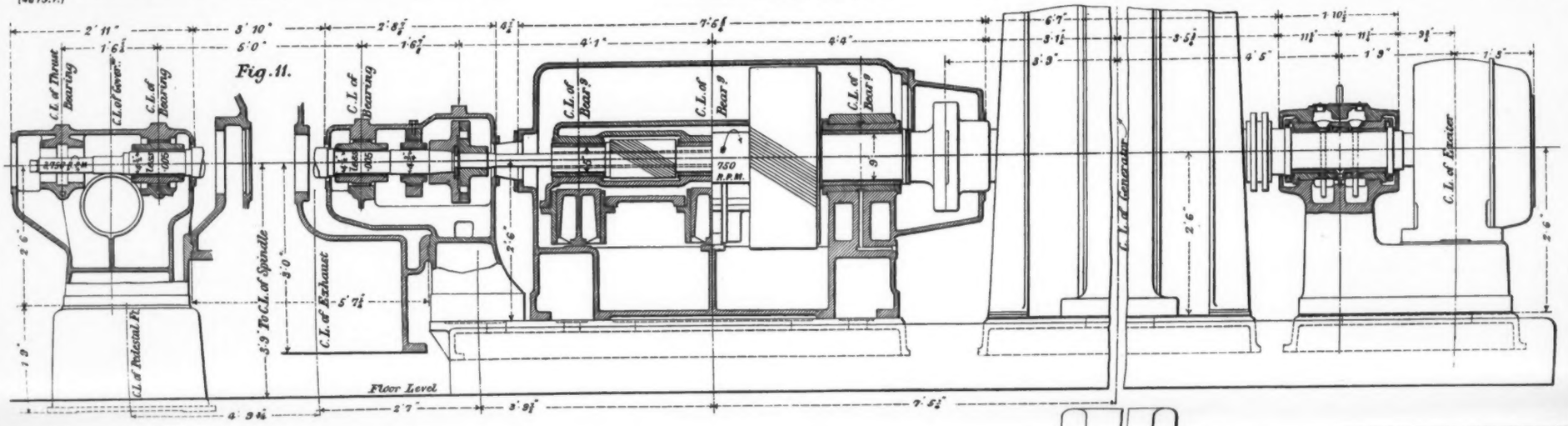

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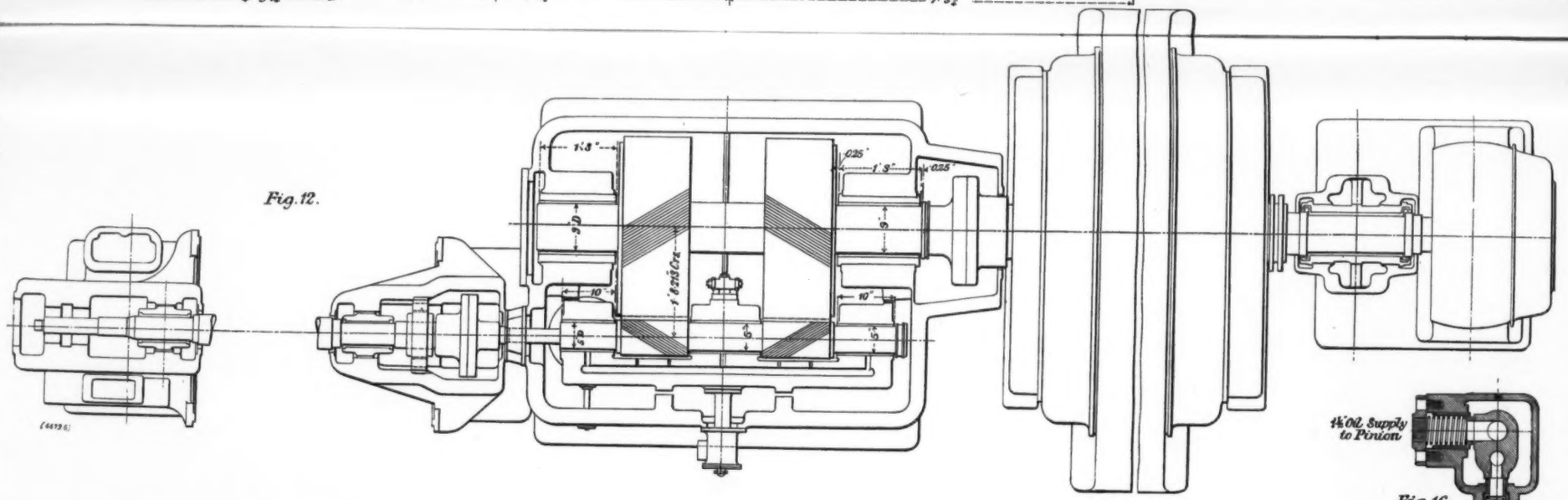

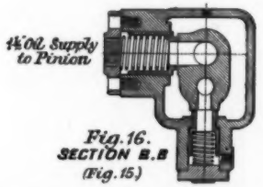

Fig. 16.
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(Fig. 15)

Fig. 13.

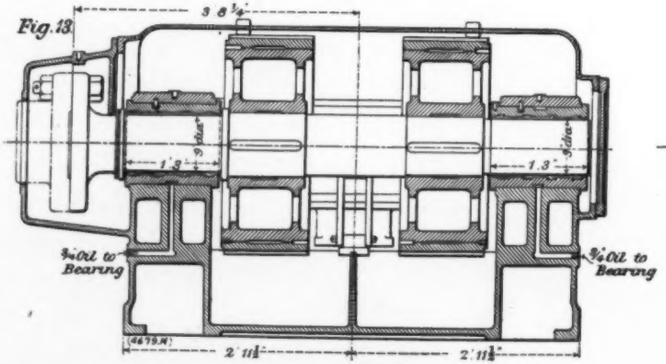


Fig. 14. SECTION AT Z.Z

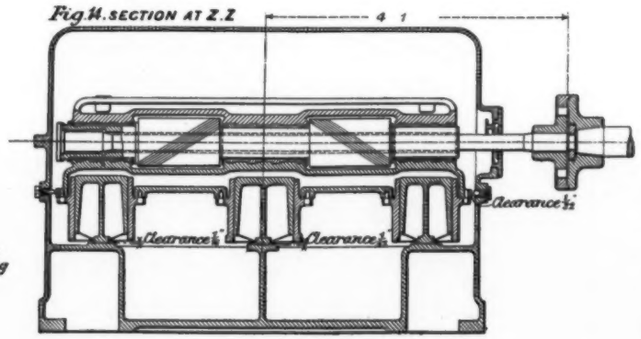
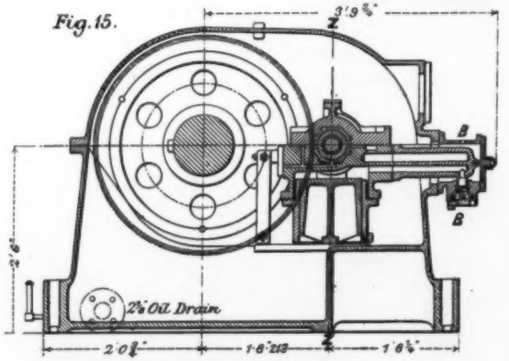


Fig. 15.



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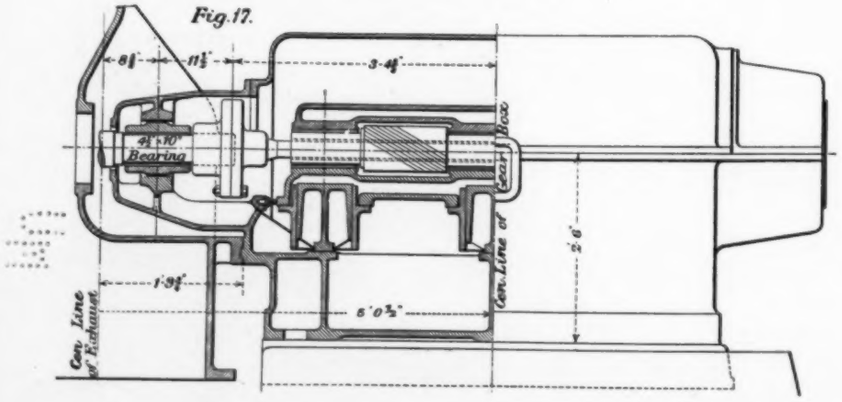


Fig. 18.

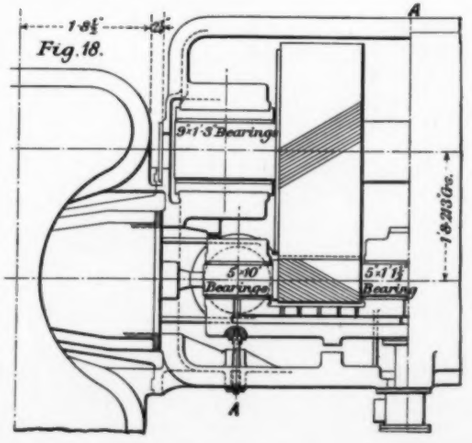
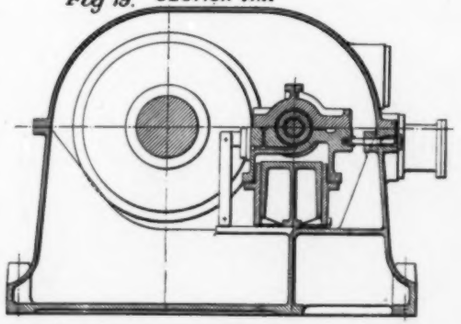


Fig. 19. SECTION A.A



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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3063 and 8598 GERRARD.

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NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, SEPTEMBER 8, 1916.

THE FUTURE RELATIONS OF LABOUR AND CAPITAL.

THE Parliament of Science is sitting in Newcastle, and the Parliament of Labour at Birmingham, and in both cities men are looking with troubled eyes to the time when the present abnormal conditions of industrial life must cease and new conditions be entered upon. In nearly all the 13 sectional presidential addresses delivered last Wednesday before the British Association for the Advancement of Science the economic and social changes which have been wrought by the war were referred to, and in no case more significantly than by Mr. Gerald Stoney, whose address to the Engineering Section we publish on page 238. At the Trade Union Congress at Birmingham the Lord Mayor, Mr. Neville Chamberlain, defined the position when he said that the aim of the working classes was that it should be worth while to live in the country they had done so much to preserve, while the president, Mr. H. Gosling, added that the key to the after-war position was the prevention of unemployment, and that the Government held in its hand that key. Mr. Stoney and Mr. Chamberlain pleaded for better conditions of life for the working classes, which, of course, includes better wages. Mr. Gosling was full of apprehensions of attempts to lower wages and to sweep away trade union regulations, which have "been given up as willingly as thousands have given their lives because deemed essential for purposes of national defence." Unfortunately the demand for higher wages and the old trade union restrictions are incompatible. Mr. Stoney pointed out that in engineering works the shareholders have received in recent years on an average 8*l.* for each worker employed, who receives 70*l.*, and that an increase of 10 per cent. in wages would practically wipe out all dividends and debenture interest. Evidently these conditions, if maintained in the future, offer no hope for the wider and more generous life desired by Mr. Chamberlain for working people. Probably Mr. Gosling is well aware of this, and that was the reason why he was silent on this point. He was full of apprehension of decreases of wages, and he more than hinted that they would be resisted by the unions by all the means at their disposal.

There is no doubt that the sympathy of the public is with the working classes. They responded splendidly to the invitation of Lord Kitchener and came forward in hundreds of thousands in the early stages of the war. They were certainly opposed to compulsory service, but it was more on principle than for personal reasons. The reports of the cases that come day by day before the Courts show that the appellants are largely drawn from the classes intermediate between the upper and the lower. Most of them have not the accumulated savings which enabled the upper and the upper middle classes to join without consideration of how their families were to be maintained, while their standard of living cannot be kept up by the Government allowances for wives and children. The working men who remained at home, engaged on the equally important, although less dangerous, business of preparing munitions, eventually gave up their trade union rules when they were finally convinced that their restrictions were helping our enemies and costing the lives of men. This was done very reluctantly, for the rules had been built up and endorsed by generations of trade unionists, and were the outward and visible signs of many a hard-won victory. Nevertheless they were given up on the distinct promise of the Government that they should be restored on the completion of peace, and if the unions insist upon the exact and literal fulfilment of that promise there will be a large measure of public pressure behind their demands.

But "the stricken field" introduces new conditions in regions far beyond those in which it is fought, and very different from any anticipated even by the most clear-sighted. Neither statesmen nor trade unionists had any idea of the changes in workshop practice which would be effected by the dilution of labour, and in making their compact they were acting largely in the dark. In the meantime a new light has arisen. It has been demonstrated that our old manufacturing methods were as inimical to the workman as to the employer, and that it is perfectly easy to replace them by others which will double or treble the output of a factory, yielding at the same time larger wages and increased profits. If this involved a system of slave-driving, which would use up the men in a few years and then cast them aside as useless, it would be a national misfortune. But we see delicately nurtured women turning out day by day, and week by week, two or three times the amount of work prescribed by trade union rules, and keeping their health and vivacity. What they can do without breakdown can surely be accomplished by men accustomed to labour from their youth. Mr. Gosling's predictions that "in view of the industrial speeding-up in war industries . . . the working life of the industrial population must tend to become shorter," find no endorsement in the present experience. They remind us of similar predictions regarding the middle classes due to the increased competition and strain in business. Statistics, however, show that life is lengthening in all classes, and that the difficulties in trade union finance are largely due to the increased numbers who live to claim retiring allowances.

In face of the undoubted fact that women of all sorts—University graduates, clerks, housemaids, teachers, idlers—are now getting at least twice as much work through machines as was formerly done by unionists, and that the work passes the most exact, and sometimes meticulous, inspection, will the trade union leaders endeavour to hold the Government to their promise? If there is any spirit of statesmanship among them they will see that a splendid opportunity has arisen for them to realise the oft-prated pretension of the partnership of Labour and Capital. Hitherto there has been plenty of evidence of the enmity between Labour and Capital, but very little disposition towards partnership on either side. The time, however, is propitious for change, and it has been rendered more so by the entrance of women into works. Formerly the interest of the employer in the employed began and ended at the timekeeper's office. Now, as our columns show, it extends to his, or her, home, and to all his requirements. In connection with works there are kitchens, canteens, rest rooms, recreation rooms, laundries, and other conveniences. Further, these are not thrown at the workers in a take-it-or-leave-it fashion. The employees are asked to elect delegates to represent them, to offer suggestions and advice, and generally to exercise the same influence as the members of a club. The president of the Congress asked if it would not be possible for the employers in this country, on the conclusion of peace, to admit workmen to some partition, not in profits, but in control. They did not ask to interfere with buying or selling, but in the daily management of the employment in which they spend their working lives, in the atmosphere and under the conditions in which they work, in the hours of beginning and ending work, in the conditions of remuneration, and even in the manners and practices of foremen. As we have shown, an immense step has been made in the last few months towards such a participation, and it should not be difficult to make it universal. But, as the Irishman said, the reciprocity cannot be all on one side. A partnership can only be worked in a spirit of "sweet reasonableness." It is not like the meeting of combatants round a table to arrange a peace, in which each sets out to wring every possible concession from the other by the threat of further hostilities. Partners must put the success of the business first, and then personal interests second, at least, and this has hitherto been contrary to the spirit of trade unionism. It has secured 70*l.* out of the 78*l.*, and has peremptorily

rejected any scheme that has been proposed to increase its share to 100*l.* and Capital's share to 18*l.*

We hear a great deal at Congresses about the organisation of labour, but the speakers know—none better—that its organisation is a farce. A trade union is like a democracy in which any one can call for a general election whenever he likes. There are always at least two parties, as is natural, and one or other is for the time being in the ascendant, and elects the governing body. But the moment that body acts it is almost certain to offend many of its supporters, because it does what is possible and not what they would like. They then join the minority and repudiate their executive, who must either resign or eat their words. This is the real reason for the obstinate clinging to the restriction of output, although the leaders know that it is scientifically and economically wrong. It is the one thing upon which it is possible to rely for a compact majority. It appeals to the socialist, the syndicalist, the lazy, the weak, the incompetent, the unfit, and the man who is "agin the Government." It remains to be seen whether our soldiers, when they return from the front, will introduce a new spirit. They will have seen the value of discipline, they will have learned that the success of an attack depends largely upon careful forethought on the part of the staff and loyal obedience on the part of the regimental officers and the men. They will remember their danger and sufferings during the time they were short of shell due to the reluctance to relax trade union rules, and their sudden elevation to a position of mastery when the munitions poured in under the new conditions. Some of them may realise that in the commercial war which will follow the signing of peace victory must be sought by the same means, and will venture to give utterance to their opinions. Unless a change occurs in trade union counsels, the outlook justifies Mr. Gosling's vaticinations. We might as well return to our military equipment of September, 1914, as to our manufacturing methods of that date. The first thing we need is a reorganisation of trade unionism by which the leaders will be given both power and responsibility. What happens under those conditions we have been taught by our colonial relations. Australia has sent us statesmen who were not afraid to speak their opinions, the secret being that they had an assured position as long as they retained a majority in the Parliament and could employ the forces of the Crown to enforce their decisions.

It must not be assumed that all the difficulties between Capital and Labour are due to the latter. The methods of employers are answerable for a great deal of the suspicion with which they are regarded by their men. Many of them are quite ignorant of correct methods of manufacture, and have only recently had their eyes opened to their own deficiencies. They imagined that they knew how to work to gauge and to produce interchangeable parts, and only recognised their disability when their goods were thrown back on their hands by the inspectors. They had pursued antiquated methods with obsolete machinery and had only kept their heads above water by cutting rates at every opportunity and by constant cheeseparing. They refused to enter federations of employers, and when obliged to enter into agreements they interpreted them in the spirit of an old-fashioned attorney. Mr. Stoney, who has had a wide experience of engineering manufacture, says "What is wanted is common honesty and common sense on both sides, for one side is as bad as the other at present." We should hesitate to endorse these words without qualification, but there is no doubt that both employers and employed will have to pursue a much more liberal and enlightened policy if we are to garner the harvest which we have fertilised by our blood and our gold. We shall certainly not have such another opportunity for years, and to let it slip for the sake of indefensible shibboleths, or by reason of ingrained prejudices, would brand us as incapable of learning and therefore of maintaining our position in the commercial world. The workman wants high wages and the manufacturer an increased output on a given capital, and there is no reason why both should not attain their desires, provided always that each recognises that the two must go together.

LIGNITE.

The first briquette press for dealing with lignite was installed in Germany in the 'seventies, but it proved up-hill work to secure for the product a market against English and German coal and Bohemian lignite. Gradually, however, this was done, and the manufacture of briquettes has caused vast deposits, hitherto neglected, to be worked with excellent results. A number of efficient briquette works have been erected during the last 10 to 15 years, and in one respect this industry may be said to have reached its consummation by the time the war broke out.

In the district between Cologne and Aachen an important lignite industry has sprung up in a surprisingly short time, and it now provides one-fourth (in 1915 23.8 per cent.) of the whole German production. Prominent within this area are the Rhenish Lignite and Briquette Company, with a share capital of 32,000,000 marks; the Roddergrube concern (22,000,000 marks); and the Zukunft concern (7,500,000 marks). The oldest and still the most important German lignite industry is located in Central Germany, and supplies more than half of the aggregate production (54 per cent. in 1915). The largest undertakings in this connection are situated in the neighbourhood of Halle, and comprise the Riebeck Company (28,500,000 marks), the Werschen-Weiszenfelser Company (14,000,000 marks), the Anhalt Company (9,000,000 marks), the Halle-Pfannerschaft Company (6,000,000 marks), the Michel concern, embracing the undertakings of Michel, Leonhard, Gute Hoffnung and Vesta. In the Borna-Altenburg district lie the German mines of the German-Austrian Company (18,000,000 marks), the Dux concern (6,000,000 marks), the Leonhard Company (8,000,000 marks), the Phönix Company (7,750,000 marks), &c. Somewhat apart from the above-mentioned lignite areas lies the Bitterfeld lignite district, of which the Berlin Electricity Works group is endeavouring, and successfully so, to obtain the control, with the Leopold mine (12,000,000 marks). In the Brunswick-Magdeburg district there is situated the Brunswick Company (11,000,000 marks). Further removed from the Halle district lies that of Niederlausitz, with the Ilse Company (15,000,000 marks), the Niederlausitz Company (16,000,000 marks), &c. At Borna are situated the Lignite and Briquette Company (8,000,000 marks), and the Eintracht concern (6,000,000 marks). In addition to those enumerated here there are a great many smaller concerns in the different districts, many of which are very ably managed and yield most satisfactory results. A number of these smaller concerns are attached to or in some way combined with the large companies mentioned above, and the latter may in any case be looked upon as the main representatives of their districts. It is of material interest to the German industry that most of these lignite deposits are situated at some distance from the coal mines, so that the two kinds of fuel supplement each other in a natural way. The whole of Central Germany is supplied with fuel from the four lignite districts referred to above, Halle, Borna-Altenburg, Bitterfeld and Brunswick; the Niederlausitz lignite deposits are conveniently located between the former and the Upper Silesian coal mines; and the Cologne lignite industry comes in between the Rhenish-Westphalian and the Aachen coal-mining districts. On the other hand, lignite deposits are not found within the leading coal-mining districts of Germany.

Apart from traffic and other disturbances caused by the war, the German coal-mining industry would have been unable to cope with the situation created by the complete stoppage of the import of English coal. The position of important German coal deposits near the frontier caused their working to be greatly impeded by military transport, &c., so that the shortage became exceedingly heavy (in August and September, 1914, for instance, 44.9 per cent. compared with the corresponding months of 1913). The calls to the front have continued to tell upon the output of coal in Germany, as will appear from the following figures:—

Production,	1913	191,500,000 tons.
,,	1914	161,500,000 ,,
,,	1915	146,700,000 ,,

A similar fate befell the Austrian lignite industry, which suffered much from shortage of labour and rolling stock, so that the imports into Germany of Bohemian lignite receded considerably. The German lignite industry, owing to its central position, was saved from much disturbance and had ample rolling stock placed at its disposal, occasionally even more than in times of peace. Lignite mining is far more independent of skilled labour than is coal mining, and its large surface deposits are very easily worked. This, for instance, applies to the Niederlausitz and Nether Rhine deposits, where it is almost all surface working, whilst in Central Germany important concerns are confined to underground working. As far as these and other lignite companies are concerned the year 1911 witnessed some very desirable amalgamations, whereby a number of surface-working undertakings were combined with underground-working concerns, an arrangement which also entailed other marked advantages. That this centralisation movement has been continued during the war is evidenced by the amalgamation of the Harbker and the Brunswick coal-mining concerns, and the attachment of the Leopold and the Auguste mines, in the Bitterfeld lignite district, to the Berlin Electricity Works group. Lignite deposits are much sought after at present, and are changing hands at increasing prices.

The German banks, of late years, have had a material share in the consolidation of the lignite, as well as of other German industries. How the capital entitled to dividend invested in the German lignite industry has increased within the last few years will appear from the subjoined figures:—

1908–9	... ...	163,600,000 marks.
1909–10	... ...	211,300,000 ,,
1910–11	... ...	218,000,000 ,,
1911–12	... ...	227,200,000 ,,
1912–13	... ...	249,400,000 ,,
1913–14	... ...	270,000,000 ,,

an increase of 106,400,000 marks, or 65 per cent., in the course of five years. At the same time the capital invested in other lignite concerns increased by some 50,000,000 marks during the same period. Objections may be taken, and have been taken, from a strict banking point of view, to this close relationship between the big German banks and the leading German industry, but so far it seems on the whole to have worked very satisfactorily. It has given the German industry a tremendous lift, and the banks do not appear to have had any cause for regret in the past. As a result many surface lignite deposits, which some 10 to 15 years ago were looked upon as practically worthless, have been worked up to great and remunerative concerns, thanks to the foresight and enterprise of the banks.

Owing to mechanical appliances for working the surface lignite deposits, the production was less hampered than coal-mining by shortage of labour. The production certainly receded from 87,100,000 tons in 1913 to 84,000,000 tons in 1914, but rose again to 88,400,000 tons in 1915. Whilst the German production of coal in 1915 showed a decrease of 23.4 per cent. compared with 1913, that of lignite increased 1.5 per cent. during the same period, at the same time marking a record production. Shortage of rolling stock and other traffic impediments at times are responsible for the figure not being still higher.

A very large portion of the lignite production is worked into briquettes, the sale of which during the war has been exceedingly brisk, and, as will appear from the subjoined table, the production has practically been doubled during the last 10 years:—

1907	... ...	12,890,000 tons.
1908	... ...	14,230,000 ,,
1909	... ...	14,830,000 ,,
1910	... ...	15,130,000 ,,
1911	... ...	16,840,000 ,,
1912	... ...	19,060,000 ,,
1913	... ...	21,420,000 ,,
1914	... ...	21,450,000 ,,
1915	... ...	23,850,000 ,,

The value of last year's production of briquettes from lignite amounts to some 200,000,000 marks.

The lignite districts are greatly interested in the production of electric energy, and the sale of this has increased materially during the war. This applies to the central stations of the Nether Rhine,

the Rhenish Company, the Rodder mine, and the Zukunft concern, and the same applies to the central German stations of the Brunswick Company, the Riebeck firm, and the Kulkwitz station of the Leipzic lignite concern. In the Niederlausitz district the Ilse Company has extended its area of supply of electric energy. In Saxony the purchase by the State shortly before the war of vast lignite deposits and the pending acquirement by the State of the Electricity Supply Company's power station at Hirschfelde, which receives its fuel from the Herkules lignite concern, has brought the matter very much to the front. In the Bitterfeld district the stations of the Elektrowerke Company, with its anticipated supply of 500,000,000 kw. hours to the Imperial Nitrogen Works, and 250,000,000 kw. hours to the Electro-Nitrate Works, the Holzweissig "Central," the Leopold and the Muldenstein "Central" of the Prussian State Railway Department, are of great importance. The industry in this district has so developed during the war that the time may not be distant when the electro-chemical industry will require all the energy generated through the medium of these rich deposits, so that nothing will be left for fuel for domestic purposes.

Further, the auxiliary products of lignite play an important part in the German industry, and a number of lignite concerns are to the fore in this connection. Thus about 450,000 tons of lignite coke and 80,000 tons of tar are produced annually, the latter product being used for the manufacture of paraffin and mineral oils.

The export of lignite briquettes is not important, and amounts only to some 860,000 tons per annum, the figure before the war.

THE PLACE OF MERCHANT SHIPS IN MAINTAINING SEA POWER.

THE Institute of Marine Engineers have the happy arrangement that the presidential chair is occupied alternately by a shipbuilder or engineer and by a shipowner. The consequence is that there is a close contact which is very desirable between those responsible for the building of ships and engines and those who are at the head of the companies through whom the hopes of the constructors are brought to fruition. This year Sir James Mills, K.C.M.G., is the president, and on Wednesday last he delivered his address. It is all that one would expect of him, because he is not only imbued with the spirit of the great dominions across the sea, but he has been for 40 years identified with one of the important and successful steamship companies working continuously to strengthen the spirit of fealty between the home country and the dominions. It was therefore fitting that he should take some pride in the evidences of this fealty during the present time of great imperial stress, and his further remarks regarding the importance of the post-war struggle for shipping supremacy were equally forceful.

Among the many lessons which the war has brought home, with great clarity, is the need for British shipping supremacy in the future even more than in the past. The First Lord of the Admiralty, speaking on the same evening in Glasgow, was happy in his enforcement of this dictum. Primarily it is his official duty to get the maximum amount of work done for the fighting fleet, but Mr. Balfour, with that marvellous dialectical ability which ever characterises his utterances, made it clear that unless we continue to build merchant ships we cannot maintain command of the sea. The merchant ship is the necessary corollary of the fighting ship. To quote Mr. Balfour: "Men are necessary, shells and guns are necessary, but the fundamental necessity underlying all these, and without which the most ample supply of all the other necessaries would be absolutely empty and useless, is the necessity to maintain that practical command of the seas which the British fighting ships and the British mercantile marine, acting in collaboration and co-operation, and for so many glorious generations of our history, have been able to maintain." All the sacrifices we have made would be in vain "if there was not in the background that sea power and that power of using sea power that keep up connection between the mercantile marine and upon which the whole fabric of the Allied cause ultimately depends." Mr. Balfour was addressing the leaders of the trade unions, seeking to impress upon them the importance of continuing their great efforts of the past few months until the close of the war, not alone on warship work but on merchant work as well. He was anxious that they should not think of subsidiary questions, such as who should derive the profit from the working of these ships. That is a matter which can easily be left to the Treasury.

Sir James Mills based his arguments on the purely economical theory. The number of ships that have been drawn from the merchant service for purely naval work is phenomenal. When the war broke out the number of vessels calculated to deal effectively with the submarine menace could be counted by hundreds, from the destroyers down to the mine-sweepers; now, as Mr. Balfour has told us, they can be counted by thousands. There are many other duties discharged by merchantmen. Many of the ships will be so depreciated in value by wear and tear that they cannot hope successfully to take their places in the old service. There have been such things as losses by warfare, in addition to the casualties due to nature, so that the merchant fleet has been enormously depleted, and this process must continue, almost in increasing degree, with the lapse of time. Apart altogether from this, there has been considerable activity in the shipbuilding yards of neutral countries, so that in the immediate future we must anticipate keener competition than in the past, unless it is found possible to ensure the maximum amount of operative work in the building of merchant ships as well as naval ships. It rests in part with the Admiralty to permit, as far as possible, the workers of the shipyards to proceed with vessels held up for many months because of other demands; but it is of equal consequence that the workers should devote themselves as whole-heartedly to the construction of merchant vessels, because, as Mr. Balfour pointed out, such merchant ships can be of immense value not only in bringing the war to a victorious conclusion, but in ensuring that the handicap under which we must then inevitably suffer will be minimised as far as the resources of the nation permit.

THE BRITISH ASSOCIATION.

IT was not a large British Association meeting that Sir Arthur Evans addressed as president on Tuesday evening in the Newcastle Town Hall. Many familiar faces were missing, old members of many years' standing and young workers, and one feared to make inquiries about any of them. In introducing his successor in the chair, Professor Arthur Schuster, last year's president, had to speak of the loss during the past year of four past-presidents of the Association—Sir Henry Roscoe, Sir Arthur Rücker, Sir William Turner and Sir William Ramsay—and of many distinguished members like Sir Andrew Noble. The president himself referred to "our thinned ranks."

The Official Handbook to Newcastle and District, prepared for this meeting and edited by Messrs. George B. Richardson and W. Weaver Tomlinson, though larger in its compass and more technical than its predecessor of 1889, had in its industrial articles unfortunately to suppress much of the detail of the latest developments which would have made the book of lasting interest to our readers. The compilers of the various articles have more to say concerning the historical development of the industries than concerning their actual status, though complete lists of firms are given. Reference to the great Elswick works is practically omitted, and some of the articles—for instance, that on shipbuilding, by the first-named editor—are almost disappointingly general. The article opens: "Ships are a fascinating study," and goes on to state that "No one man can be said to have invented the ship." The tonnage launched from the North-East Coast district during the 20 years from 1894 to 1913, we see, has steadily risen from 545,000 tons to 1,172,058 tons, and has throughout that period represented one-half of the tonnage launched in the United Kingdom, the totals for the 20 years being 15,915,438 tons (North-East) and 31,296,395 tons (United Kingdom). This statement indicates another difficulty for the compiler. The handbook could not deal with the industries of the whole North, and to say that it appears hardly possible and profitable to consider the Tyne industries apart from the industries of the North-East, and, in fact, of the North, would not mean to belittle the importance of the Tyne and of the northern metropolis on it. The mining district of the North of England embraces Northumberland, Durham and the North Riding of Yorkshire, as well as Cumberland, Westmorland and parts of Lancashire, and the coal and coke from Durham and Northumberland are the chief fuels for the industries of the whole districts.

There has been an enormous expansion of coal and stratified mining and a decline of vein or unstratified mining in the district. According to Mr. J. Boland Atkinson's notes on Mining and Quarrying (handbook), 114,280 people were, in 1887, employed in coal and stratified mining—in which Durham and Northumberland almost count alone of those counties—and 247,011 people in 1913; while vein and unstratified mines—in which the other counties predominate—gave employment to 12,792 and to 8,835 people in the same years. The iron and steel industry (Professor Henry Louis) of the Tyne certainly dates back to the Roman period; it declined in Northumberland after 1850, but expanded, thanks to Cleveland ores and shipped ores, rapidly in Durham, where the pig production exceeded 1,107,000 tons in 1911 and was 876,000 tons in 1915. In the year 1915 Great Britain produced about 4,000,000 tons of acid steel and 3,000,000 tons of basic steel, of which the two counties contributed one-seventh; they had no share in the production of Bessemer steel, 1,300,000 tons. Electric steel furnaces of the Stassand and Stobie type are used by three firms; two other firms make ferro-alloys in electric furnaces; the one 15-ton Stobie furnace is the largest in the kingdom. As regards marine engineering, Professor R. L. Weighton shows that the North-East Coast and the Clyde have, since 1900, kept apace in output, the outputs in the horse-power of marine engines of the North-East, the Clyde and the kingdom totalling in those 14 years, respectively, 8,557,000, 8,580,000, and 23,306,000; the output of Parsons marine turbines rose in the same period from 11,500 to 239,500 shaft horse-power, the output of 1912 being 256,800 h.p.

As regards electrical industries, Messrs. Gerald Stoney and G. B. Richardson do not fail to point out that the North-East is the birthplace of several most important of these industries. There Sir Joseph Swan produced the first practical incandescence lamps in 1879, and lighted premises and streets with them; Sir Charles Parsons made the steam turbine which helped the high-speed dynamo to success; and the remarkable scheme of electric power distribution and proper coal utilisation took its roots there. The glow-lamp manufacture itself—with which Mr. A. Spiller deals—no longer has its home on the Tyne. Lead, copper and antimony (Mr. H. T. H. Leathart and Mr. C. Cookson) are not important on the Tyne and have declined. That applies also to chemical industries, as we already remarked in our previous article; but more scientific methods and the recovery of coke by-products are coming in. Electro-chemistry (Professor P. P. Bedson) has gained a firm footing at Wallsend in the Castner-Kellner sodium works and the vitreosil works (fused silica). The grindstone trade of Newcastle (Mr. J. G. Hodgson) retains its ancient importance; about 15,000 tons are exported annually to all parts of the world. We may add that visits to works have finally had entirely to be abandoned for this meeting.

THE PRESIDENT'S ADDRESS.

ORIGIN OF CIVILISATION IN EUROPE.

A presidential address on archæology had not been delivered since the father of this year's president, the late Sir John Evans, for many years treasurer for the Royal Society, had occupied the chair at the Toronto meeting of 1897. While not reviewing the progress that archæology has made in those two decades, Sir Arthur Evans, D.Litt., P.S.A., F.R.S., Extraordinary Professor of Prehistoric Archæology at Oxford, was able to show that a

wholly new standpoint has been gained in the history of the survey of the human race. The gap between the Palæolithic and Neolithic ages, a yawning gulf still to the past generation, is being bridged over. Palæolithic man of the late Quaternary period had artistic faculties that would attract attention in our days; and neither that high culture nor Hellenic civilisation, the wonder-child of classical scholars, can be confined to any one particular country or to one particular race. Civilisation, in brief, is far older and far more general than is mostly assumed, and the co-existence of high and low grades of civilisation is not a characteristic of historic ages alone. The men that built the Roman Wall and the Pons Aelii worshipped the peculiar deities of the many parts from which they hailed, Roman and Greek gods in the ordinary sense, the Persian Mithra, the Phœnician Baal, and the Jupiter of the double axe, the divine emblem or Labrys of the Palace sanctuary of Knossos in Crete, where Sir Arthur Evans has been principally excavating in late years. The cave men of the Reindeer Period have also left traces of their arts over wide portions of the earth.

It was with this age that Sir Arthur dealt in the first part of his address after having in his introduction referred to recent explorations on the Tyne. The people who dwelt in the caves of Aurignac and Altamira, Balzi Rossi, and Cogul in south-western Europe, on both sides of the Pyrenees, in the Neanderthal near Düsseldorf on the Rhine, and further north and east, apparently, as well as on the shores of the Mediterranean, and in South Africa among the Bushmen, were fresco painters of extraordinary technical resource. Their engravings and life-size and wonderfully lifelike clay figures of bisons, reindeer, &c., go 10,000 years further back than the ancient monuments of Chaldæa and Egypt. They painted with charcoal, ochre and white, in delicate shading, and drew their outlines not in crude traditional stiffness, but with a bold originality and in true perspective; their mortars and palettes have been found; the cave-walls are not covered with smoke, for they possessed stone lamps; they hunted with dogs and jackals, though not, as a rule, with bow and arrows—also found, however, in some parts; their women wore gowns and sashes, and their signs resembled or actually produced the letters of the alphabet. The fine-built Cro-Magnon race predominated among these cave-dwellers of the Reindeer Age; but there were other races, even negroid skeletons have been found buried together with them, evidently with the same rites, and a similar primeval culture had apparently spread to Denmark, Scandinavia and central and eastern Europe and Asia, to North Africa, and to the Bushmen in South Africa.

In the second part of his address Sir Arthur Evans pointed out that though the culture of the Neolithic race in Europe was certainly Eurasiatic in type, and took its main roots in the valleys of the Euphrates and Nile, as has long since been accepted, that culture must be traced back far beyond Babylonian civilisation, which had so long been known only under its Semitic guise, and far beyond the historic Egyptian dynasties. Hellenic culture did not stand out pre-eminently, and was no isolated phenomenon. Sir Arthur is inclined to see more particularly in Crete the Mid-Sea land, the half-way house between three continents, the cradle of European civilisation. In the Hill of Knossos he has found traces of life of an astounding modernness even in sanitary respects; the builders of the palaces of the Minoan priest-kings far outdid the similar work in Egypt and Babylon.

Concluding, Sir Arthur lamented that scientific intercourse was broken and its cosmopolitan character obscured. We had all to bow before the hard necessity of the moment. Of much we could not judge. Great patience was demanded; let those who still had the opportunity of doing so prepare for the even more serious struggle that must ensue against the enemy in our midst, ignorance, apathy, the non-scientific mental attitude. We heard of "Commissions and Inquiries." But the inveterate attitude of our rulers towards the higher interests that members of the British Association were at Newcastle to promote, was too clearly shown by a single episode. At a time when it might have been desirable to keep open every avenue of popular instruction and of intelligent diversion, the galleries of our National Museum at Bloomsbury were entirely closed for the sake of the paltriest saving—"three minutes, it was calculated, of the cost of war." "Perhaps the worst economy to which we are to-day reduced by our former unpreparedness is the economy of Truth. Heaven knows!—it may be a necessary penalty. But its results are evil. Vital facts that concern our national well-being, others that even affect the cause of a lasting peace, are constantly suppressed by official action."

It was an interesting address, though Sir Arthur might perhaps have borne the fact more in mind that he was addressing the Association, and not his own Anthropological Section H.; terms like the Cro-Magnon type might have briefly been introduced and explained. The vote of thanks was coupled with the welcome to the City, by the Lord Mayor of Newcastle, in a breezy speech; it was seconded by a former president of the Association, Sir Edward Schäfer.

We begin our notice of the sectional proceedings with Section G.

SECTION G.—ENGINEERING.

THE first meeting of Section G was held at 11 a.m. on Wednesday last in the rooms of the Mining Institute, Neville Hall. The proceedings opened with an address by the president, Mr. Gerald Stoney, B.A.I. (Dub.), F.R.S., M.Inst.C.E. This address dealt with a number of extremely important questions on industrial economics, and is reprinted in full on page 238.

LIMIT GAUGES.

A paper on "Limit Gauges" was next read by Mr. R. T. Glazebrook, C.B., F.R.S., the head of the National Physical Laboratory. The paper described in detail the methods adopted at Teddington for checking the dimensions of various types of inspectors' gauges, and we commence its publication on page 236. The discussion was opened by Sir Charles Parsons, who said that the work at the National Physical Laboratory described by the author had been of the utmost importance in facilitating the making of munitions. As a member of the Tyne and Wear Munitions Board, the speaker's attention had been early and forcibly called to the great dearth of gauges, a sufficient supply of which was long unobtainable. In taking measures to mitigate the trouble the speaker had made the round of the workshops on the Tyne and Wear, examining their tool rooms, and had found an equal dearth of high-class manufacturing facilities. His own works possessed a fairly good tool room, and the men there worked readily to $\frac{1}{1000}$ in. which had been considered a sufficiently close limit for turbine work. They had not, however, been called on previously for greater accuracy than this, but limits of, say, $\frac{1}{3000}$, were required in the gauges demanded. His firm accordingly sent the men up to the National Physical Laboratory, where they were shown how to make and test accurate gauges. When, on their return, they tried to do the work, and failed, they were again sent to Teddington for further instruction. In the end the result exceeded all expectations, and the men really enjoyed this high-precision work once they had learnt how to do it. He only wished that the National Physical Laboratory was ten times as big as now. Such a development would be exceedingly good for the country, and would be required, he thought, even more after the war than it was at present. In his view, the Laboratory developed on such an enlarged scale would be of the greatest assistance in the ensuing keen competition for trade.

Professor J. E. Petavel, who followed, said that Dr. Glazebrook was to be congratulated not merely on the results attained at the Laboratory in the testing of gauges, but also on the rapidity with which the matter was taken up and pushed to a successful issue, once the word was given that important munitions work was being held up from a lack of reliable gauges. The National Physical Laboratory did much more than merely receive and check gauges. A record was made of the characteristics of each gauge, and these gauges were also stocked, issued, checked and taken back into stock in accordance with manufacturers' requirements. The Laboratory required, accordingly, not only technical and scientific skill, but organising capacity, and a considerable knowledge of modern systems of recording and cataloguing, so that out of the hundreds of thousands of different classes of gauge, any individual one could be traced through all its various stages.

Mr. W. A. Price, who spoke next, said that the work described by Dr. Glazebrook had for him a special interest, since he had, some years ago, acted as secretary to a committee which had tried to do for small screws of ¼-in. diameter and less similar work to that described in the paper. In this attempt he thought he might say they had failed. He had felt rather bitter about it at the time. This feeling had, however, now disappeared since he had seen the procedure at the National Physical Laboratory. There the gauging of screw threads was done with a skill and accuracy which his committee of 10 or 15 years ago never dreamed of. His experience on that committee had made him realise how extremely valuable to the country was the work described by the author. He believed only those who had gone through the drill of the Small Screws Committee of 1900 would appreciate this to the full.

The next speaker, Mr. Brackenbury, expressed his appreciation of the patient study necessary not merely to devise adequate methods of checking the gauges, but in deciding what tolerances should be allowed. The work involved was enormous. He had been particularly struck by the simple method of comparing gauges by optical projection, and asked the author if the apparatus required for this was on the market.

Professor H. Louis asked the author whether he could give any information as to use of limit gauges in connection with the Brinell hardness test. The plan was to measure the depth of the depression made by the use of two limit gauges, one of which should "go" and the other "not go." The method saved an enormous amount of time and sufficed to tell whether the hardness of the steel tested lay within the required limits.

Mr. C. E. Stromeyer said that much as he appreciated the author's paper, he thought it required supplementing by another showing how the gauges were to be used. The ill-treatment by the inspectors in many cases was almost incredible; gauges were forced on and off and completely ruined in no time.

Professor G. W. O. Howe asked who was responsible for fixing the tolerances admitted for the different parts of a shell.

In reply, Dr. Glazebrook said that the limits about which Professor Howe had inquired were settled by the Chief Inspector, Woolwich, the National Physical Laboratory having nothing to do with this matter. He quite agreed with Mr. Stromeyer as to the importance of teaching inspectors how to use gauges. He could have given slide after slide showing the damage done to gauges after use in works. In reply to Mr. Brackenbury he said that he had not yet been able to get a firm to undertake the manufacture of the optical testing plant described in his paper. The difficulty was that it was thought better to employ the men on munitions, but he was in hopes that the "optical" munitions department would agree to manufacturing opticians making the apparatus (for sale) to the designs of the National Physical Laboratory. He had been interested in Professor Louis's description of the application of limit gauges to the Brinell test, and had no doubt that Dr. Stanton would be glad to try the plan. It might be of interest to state that the two gentlemen more directly responsible for the work described in his paper had a close connection with Newcastle. Mr. Sears, who carried out the gauge testing and had designed the tools used, had obtained his training in the Newcastle district, and Mr. Price, who had charge of the stores and had originated the methods of calculating and recording, also came from the same locality.

At the conclusion of this discussion the meeting adjourned, it being decided to postpone to the following morning (Thursday) Dr. Stanton's paper on "The Principles of Similitude," which stood next on the list.

(To be continued.)

"SOME ERRORS IN STEAM TABLES."

To the Editor of Engineering.

SIR,—The very interesting article, "Some Errors in Steam Tables," in your issue of June 6, 1916, raises the question of thermodynamic self-consistency with respect to certain steam tables, and quotes two formulæ of Professor Callendar's as much more satisfactory. Let us examine these formulæ from the same point of view. They are:

$$V = 0.5948\,\frac{T}{p} - k,$$

$$V = 1.2464\left(\frac{H - 835.2}{p}\right) + 0.0123,$$

where k is a function of temperature only, the values of which at various temperatures are tabulated in the article.

The first of these equations, being an equation of state in the ordinary sense, necessarily involves certain limitations on the possible variation of Cp, for

$$\left(\frac{\delta V}{\delta T}\right)_p = \frac{0.5948}{p} - \frac{d\,k}{d\,T},$$

$$\left(\frac{\delta^2 V}{\delta T^2}\right)_p = -\frac{d^2 k}{d T^2} = -\frac{1}{T}\left(\frac{\delta C_p}{\delta p}\right)_T,$$

and, by integrating,

$$C_p = T\,\frac{d^2 k}{d T^2}\,p + \phi\,(T),$$

where $\phi\,(T)$ is the "constant" of integration.

Turning now to the second equation, we have

$$H = \frac{p\,(V + 0.0123)}{1.2464} - 835.2,$$

and, therefore,

$$C_p = \left(\frac{\delta H}{\delta T}\right)_p = \frac{p}{1.2464}\left(\frac{\delta V}{\delta T}\right)_p = \frac{0.5948}{1.2464} - \frac{p}{1.2464}\,\frac{d\,k}{d\,T}.$$

These two formulæ for C_p will be consistent only if

$$T\,\frac{d^2 k}{d T^2} = -\frac{1}{1.2464}\,\frac{d\,k}{d\,T},$$

a differential equation that determines the form of k as a function of T. Its solution is

$$k = A\,T^{0.1977} + B,$$

where A and B are two constants of integration.

But the values of k tabulated in your article do not seem to follow any such law. For if we take, say, the first and last, namely:

$k = 0.665$, when $t = 122$ deg. F., or T = 581.6 deg. F. abs.
$k = 0.060$, when $t = 662$ deg. F., or T = 1121.6 deg. F. abs.

and solve for A and B, we get

$$A = -1.240 \text{ and } B = +5.028.$$

The middle entry in the table, corresponding to $t = 392$ deg. F. or T = 851.6 deg. F. abs., ought, therefore, to be

$$k = -1.240\,(851.6)^{0.1977} + 5.028 = 0.323,$$

whereas it is

$$k = 0.175.$$

It follows that if k has the values tabulated in your article, the two formulæ are thermodynamically inconsistent. It is probable that, with a little ingenuity, one could devise a problem of some practical interest that would exhibit this inconsistency in a more exciting and vivid fashion, but it scarcely seems worth while.

It must not be inferred from this that Professor Callendar's formulæ are to be rejected. On the contrary, they are doubtless fairly accurate and very valuable approximations to the truth. The real point would seem to be that thermodynamic inconsistency in such matters, while always to be deplored, may nevertheless be by no means as serious a matter on the one hand, or as easily avoided on the other, as one might think. In the particular case cited in your article the discrepancy between two correctly computed results when one set of tables is used is annoying, and the agreement when the other set of tables is used is agreeable. But it by no means necessarily follows that the last result is more certainly right than either of the others. In fact, unless Professor Callendar has at his disposal sources of experimental information which have not yet been made public, it seems to me very possible that the discrepancy in question reflects more faithfully the actual limitations of our present knowledge of superheated steam than does the agreement.

In closing, I might suggest that any reader who is interested in going more deeply into the history of the discrepancy in question, which is essentially the old problem of reconciling observed volumes and observed specific heats, will find a somewhat lengthy discussion of it in a paper on the properties of superheated steam in the Proceedings of the American Academy of Arts and Sciences for 1909, and in later papers by Jakob and by Goodenough.

I am, Sir, Yours very respectfully,

HARVEY N. DAVIS.

Cambridge, Mass., August, 1916.

[Unfortunately for our correspondent, the error to which he calls attention lies in his own calculation and not in Professor Callendar's formulas. The term k in our article is equal to $b - c$ where b denotes the co-volume and c the co-aggregation volume in the equation

$$V - b = \frac{777.8}{144}\,\frac{R\,T}{p} - c,$$

where c has the value

$$0.4213\left(\frac{671.58}{T}\right)^{4.5}.$$

The two equations quoted by Dr. Davis from Professor Callendar's steam tables are exactly consistent. The discrepancy which he appears to have discovered is due simply to an elementary error in his own calculation. He has omitted to notice that the first expression which he deduces for the specific heat at constant pressure C_p gives the result in mechanical units, whereas the second is expressed in thermal units. Equating the two expressions naturally leads to very grave inconsistencies, owing to the omission of the necessary reduction factor from mechanical to thermal units, namely, 144/778 in the present instance. If the first of his expressions for C_p is multiplied by this factor to reduce it to thermal units before equating it to the second, the resulting differential equation for k given by Dr. Davis becomes

$$T\,\frac{d^2 k}{d T^2} = -\frac{13}{3}\,\frac{d\,k}{d\,T},$$

the solution of which is,

$$k = A\,T^{-\frac{1}{3}} + B,$$

in exact agreement with the expression given by Callendar.

In our test of the tables criticised we compared integrals and not differentials. Errors are magnified on differentiation, but are made relatively smaller by integration. It is partly for this reason that we compared integrals in criticising the tables in question. In the main, though, the course was adopted because the quantities compared were those with which the engineer has to deal. If, however, derivatives are to be compared, the errors in the tables in question are very much greater than was implied in our article.

We have, for example, the relation

$$C_p = \left[\frac{d\,H}{d\,t}\right] = \frac{777.8}{144}\left[\frac{d\,V}{d\,T}\right]_p\left[\frac{d\,P}{d\,T}\right]_\phi.$$

In the tables criticised we find that at 290 lb. per square inch and a temperature of 564.4 deg. F. the one value for Cp is 0.510 and the other value 0.621, the error being thus 22 per cent. In Callendar's tables both values agree.

Returning to the main question, it is all-important to note that the error in the tables criticised was unsuspected until the attempt was made to apply them to the discussion of some extremely careful turbine tests made for their own purposes by the builders of the machine. Every conceivable precaution was taken to secure accuracy, but it was impossible to reconcile (using these tables) the observations *inter se*. It was only after exhausting every other explanatory hypothesis in vain that the idea arose of examining the tables themselves, and then the source of the trouble became immediately apparent. The tables turned out to be insufficiently accurate for modern practical requirements. On using Callendar's tables, on the other hand, the whole of the discrepancies disappeared. The whole discrepancy arose from an uncritical adoption of experimental results obtained by methods incapable of yielding reliable figures. By other methods practically accurate figures have been obtained, and these have been used as the basis of Callendar's tables.—ED. E.]

THE SUPPLY OF TECHNICALLY TRAINED YET PRACTICAL MEN.

To the Editor of Engineering.

SIR,—The splendid article by Mr. Orcutt, published in your issue of ENGINEERING of August 4 (page 110 *ante*), should be a clarion call to the home people to look abroad and realise the position into which we, as an industrial people, are slowly yet surely slipping; this position is very largely the result of getting into a routine, rut, or groove, which has finally worn so deep that we cannot see over the side, or see what our competitor is doing; and hence fail to profit thereby.

More than a year ago Dr. W. C. Unwin, President of the Institution of Mechanical Engineers, gave a prominent place to the thorough and well-diffused system of technical education as among the causes which have contributed to the phenomenal German industrial development. The German Government have done much to recognise in a practical manner the interdependence of science and industry, yet, even so, they are but following American practice, which has made immense strides and revolutionised methods of manufacture. The pill has a bitter taste for the British industrialist, but the supremacy can be regained if we take a broader view of the position than is presented by conditions and methods prevailing in our own country; otherwise we are getting perilously close to yielding place and position in the industrial world to the more wide-awake Americans and Germans, who, without doubt, are our most serious competitors.

The two most urgent needs in our present industrial conditions are certainly the lack of skilled mechanics with technical training, and practical leaders with organising ability. If we can develop an organisation which will provide these, we are taking a big step towards regaining our trade supremacy.

It is scarcely necessary to recapitulate the history of our Trade Schools, Guilds, &c., down to our own indentured apprentice days; suffice to say that while excellent in their way, modern methods of manufacture have outstripped the methods of training men. The system of paying premiums for apprenticeship, coupled with the fact that little or no wages were paid during the period of training, effectually closed the door upon a very large proportion of the rising generation, whose parents were not in a position to expend money upon the training of their sons, but were, on the contrary, looking for the time when they would be receiving monetary assistance from them, and it is well to remember that it is from this class of people that many of the most prominent engineers have arisen in spite of the financial handicap, and made themselves leaders in the engineering world. To-day the word apprentice has become a misnomer entirely—scarcely any employers are taking interest in the training of men—and beyond the fact that youths are engaged at a low wage and broken in on one machine or one job and there left to work out their own salvation, no instruction is attempted beyond what an already overloaded foreman or charge hand can bestow, and technical training is not dreamed of, the inevitable and deplorable result being evident to-day in the absolute famine of trained mechanics; and if it is true of the mechanics, what chance is there of providing foremen, shop superintendents, supervisors, and works managers? Contrast this slipshod method with American and German practice, where a lad is paid a wage which is sufficient to render him self-supporting and self-respecting from the very start, thus tapping a vast supply of potential labour which in this country scarcely gets any chance. This potential labour is equally as good here as in any other country. Of latent talent there is an abundant supply—the thing needed is ways and means of discovering and drawing out that talent. In many large concerns native talent receives no encouragement whatever; for when positions of responsibility are to be filled, outsiders are introduced, simply because there exists no machinery for knowing what material is available in the works. This would be taken care of by a well-thought-out scheme, which would provide an organisation whereby lads would be trained in practical work, while at the same time their technical training would be taken care of, thus forming a nucleus of men trained to think intelligently which could be drawn upon for the future supply of officials for works administration.

Many of the large concerns are in a position to go ahead at once in the effort to provide technically trained yet practical men, but even with these the problem of providing a thorough systematic training for their future officers and men is of such magnitude as to warrant a conference of representatives being held to decide upon what common lines to proceed.

Regulations governing any apprentice scheme should be flexible enough to accommodate the especially bright, the average, and the slow lad, while the supervisor of apprentices should be a broad-gauge man of unswerving integrity and honesty of purpose. The general plan should be twofold:—

1. Shop instruction in the particular trade, and
2. Instruction in educational subjects connected with that trade.

It would appear that the most profitable course to pursue in connection with the practical instruction of apprentices would be for all work to be part of the regular shop output, manufactured under the supervision of an apprentice shop instructor who would have charge of the lads while in the shops.

The theoretical work should be held in a room on the company's premises, and should be arranged so that each apprentice may progress as rapidly or as slowly as his ability allows—there is nothing more disheartening to a slow lad than to know that he is unable to keep up with the rapid progress made by a few of his class-mates. All principles are more easily grasped if taught through problems closely connected with the actual shop work upon which the apprentice is engaged, and if the language used employs the shop terms and expressions so much the better. The curriculum should be made to suit the requirements of the various trades, and should be more elementary than that usually found in technical classes. In the case of engine building, automobile manufacture, and allied engineering trades the educational work may be grouped into four chief divisions, viz.:—

English,
Mathematics,
Mechanics,
Mechanical Drawing.

The purpose of the *English* is to enable the lads to express themselves easily and clearly, to write a decent letter, and to make a report which would be intelligent and intelligible. *Mathematics* is, of course, an essential to any first-class mechanic, and the various subjects considered may be arithmetic, mensuration, *i.e.*, working out areas and volumes and other problems useful in estimating, elementary geometry and trigonometry, and an elementary course in strength of materials. *Mechanics* might consist of an elementary course of physics, gear designing and power transmission, both mechanical and electrical; while *Mechanical Drawing* would include both sketching and instrumental drawing. The value of the former is obvious in illustrating any special point; while the latter is primarily not intended to teach the apprentice to become a draughtsman, but to enable him to understand the working drawings more readily, and this instruction may start directly on working drawings of actual machines or other manufactured parts, and yet should advance so gradually that even a dull lad can make headway; no time should be taken for pure theory; skill in drawing lines and printing dimensions, lettering, &c., would be obtained incidently while making useful drawings. Blue-print sketches may be used to assist the instructor, but these should be made so that they cannot be copied, and should leave more or less to be worked out by the apprentice himself. Problems should be so mixed with facts and so combined in the practical application of natural laws that in many cases they do not appear to be mathematical problems at all. The interest of the apprentice may be further held by varying the standard of difficulty and mixing the easy and hard problems, as they are apt to come into practice.

The different companies' drawings, standards and records, facts and data from the technical press, suggestions from shop superintendents, problems from the shop draughting room, hints from instructors, and points picked up in conversation with foremen and mechanics should all be made use of in the class-room. An excellent

plan is to install experimental apparatus in the school-room so that natural laws may be illustrated but not necessarily proved, as it is the intelligent application of these laws and not their proof which is desired. Models and actual machines may be used for illustration—in screw-cutting problems, for instance, the gears may be fitted on to the lathe and revolved as a check to the method of figuring. Instruction in valve setting, compression, &c., can be simplified if an engine is arranged to run with compressed air.

The practice of holding classes after the day's work is not a good one, and has not proved successful. At the same time a certain amount of home work should be expected from each apprentice, and in this connection it is interesting to note that the plan of holding classes during working hours has been in use by the British Admiralty in connection with dockyard apprentices for many years with entire success.

An important feature of any training scheme would be the keeping of records of each individual apprentice, which should show ability at the trade, noting especially speed and accuracy, standing in class, initiative, personality, adaptability, disposition and character, and these records should be combined, so that at the end of the period of training, which should be for a period of four years, the career of the apprentice can be shown at a glance. Various incentives could be offered the lads to do good work; two weeks' vacation with pay could be given to those who attain an average of, say, 95 per cent. for the year's work, while prizes could be awarded to lads who are first in their particular class—such prizes may consist of tools which the young fellow may need in his progressive shop work; while good text-books could be offered to lads who are in their last year.

Special emphasis is laid upon the importance of selecting the man to handle the apprentice; that he should be an able man goes without saying, but he must also have an aptitude for teaching boys and be able to enter into boy life thoroughly and wholeheartedly—in short, he must have the capacity for making friends with a lad and gaining his confidence. Much will depend upon the personal touch maintained between instructor and apprentice in determining the class of work or branch of service for which the lad is best suited.

In conclusion, I would again call attention to the fact that any apprenticeship scheme should start at the bottom and provide opportunities for the ordinary shop boy, who is not touched by premium apprenticeship and special courses in technical schools, and in addition to teaching him to work and think intelligently it is as well to keep in view the more important side of the problem—the development of the boy's moral character and the ability to think straight instead of what is all too prevalent to-day—allowing others to think for him.

I am, Yours truly,
GEORGE BLACK.

London, August 30, 1916.

ENGLISH AND AMERICAN WEIGHTS AND MEASURES.

TO THE EDITOR OF ENGINEERING.

SIR,—As interesting to British engineering and commercial interests, would it not be well to remind your readers from time to time that the United States of America avoirdupois measure of 1 ton, when quoted simply as a ton and not specifically as "a ton of 2,240 pounds," is a ton of 2,000 lb. only.

Also that the United States gallon is a wine measure gallon, having a cubic capacity of 231 in. only, against the British cubic capacity of 277.463 in. per gallon.

In commercial affairs, when quotations are received *abroad* from a British and an American house, each quoting "per ton," or giving, say, the capacity of a pump at so many gallons, the foreigner is unconsciously (so far as he is concerned) often deceived into placing his order with the United States on account of the apparently cheaper tonnage price or the apparently greater pumping capacity.

From wide personal knowledge obtained whilst touring foreign countries, the writer knows that this point deserves more consideration than it generally receives in Great Britain. Therefore, if you are in agreement as to the desirability of bringing these points to prominent notice occasionally, perhaps the publication of this letter will serve that purpose at present.

Yours faithfully,
C. T. EVENNETTE.

London, September 4, 1916.

DRAUGHTSMEN.

TO THE EDITOR OF ENGINEERING.

SIR,—Apparently my letter has touched up some of your correspondents, and I am prepared to concede that we may not all think alike in these matters, but to my mind it does seem a bit low down in war time, when the workman has given up the small holiday he has, for the draughtsman to claim his privilege as a draughtsman and go off for his fortnight fully-paid holiday, leaving the workman toiling at the bench, and for the draughtsman to come back and say he is a workman and claims time and a quarter for working on Bank Holiday.

I cannot help thinking that there are others in the drawing office who would take the same view, though probably not of the sort who write to the papers and work up agitations. If the movement is of the high-souled character that some of your correspondents suggest, why this concern about such a very sordid point as time and a quarter for working on holidays in war time? The workman, if he draws time and a quarter, can at least feel that he has given up his short holiday, but the draughtsman has taken, and is taking, his long holiday as usual.

Draughtsmen have always considered themselves a cut above the rank and file, and this new desire to be called workmen, and to copy their ways, is degrading the drawing office; in fact, it suggests that the movement does not emanate from the best class of draughtsmen but has probably been inspired from outside by the workmen. It is satisfactory to note that the movement is not intended to harass and plunder employers; because any fair-minded person must admit that the employees as a body in this war time have been more greedy, more ready to exploit their country's peril for their own aggrandisement, than the employers. I say as a body, but, thank God, there are millions of noble exceptions, men who have given up everything, even life itself, for their country, and it ill becomes those who stay at home, safe and comfortable, to be greedy of filthy lucre and employ their time in working up agitations when all sections of the community need to be pulling together. The only chance for England in the commercial struggle which is going to follow this war is for everybody to recognise that the interests of Capital and Labour are identical and not antagonistic, and for all to work together for the common weal.

What chance are we going to have in the world competition if wages and salaries are forced up to an altogether unnatural level? As your correspondent, "A Member," points out, it is just this which has been largely responsible for the present inflation in the cost of living, which, again, furnishes the excuse for further demands.

One of your correspondents hints darkly at what is going to happen after the war, presumably when the Association fulfils its mission—which mission, perhaps, most of its members are unconscious of—and falls into line with the other Associations for the great attack, which may yet do more harm to the country than ever the Germans have been able to do. When shall we learn, commercially, to combine for an attack upon our common enemies and not for the purpose of fighting among ourselves?

I am sorry if my views should prove unpalatable to some of your readers, but the Association has been having things all its own way in your columns, and I think you will agree that it is only fair that some of the rest of us should be allowed to have a say, at any rate until the time comes that we have all got to toe the line and do just what the Association tells us and, like the trade union members, no longer dare call our souls our own.

Even such inestimable benefits as time and a quarter for working on holidays in war time may be too dearly purchased at the expense of freedom and self-respect.

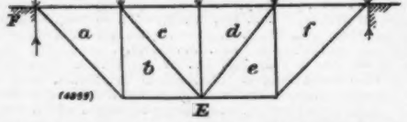
Yours truly,
"CHIEF DRAUGHTSMAN."

A VARIATION OF BOW'S NOTATION.

TO THE EDITOR OF ENGINEERING.

SIR,—If structural frames are lettered with capitals, according to Bow's notation, time is lost in locating members when the stresses are tabulated.

It is convenient to use capitals for external forces and small letters for the panels, as shown in the accompanying illustration. By so doing it will be seen that any combination of capitals denotes an external force; a capital and small letter together denote a chord



number, and any combination of two small letters denotes a web number—either a diagonal or a vertical. For example, CD is an external force, Cd is the stress in a chord member, and cd is the stress in a web number.

I have used the method for some years, but do not remember having seen it described.

The object of this note is to give publicity to the method and not to claim priority.

I am, &c.,
H. H. BROUGHTON.

Brighton, September 5.

"THE PRINCIPLE OF RELATIVITY."

TO THE EDITOR OF ENGINEERING.

SIR,—As you wisely stated at the end of the article which appeared in your issue of August 11: "For the advance of exact science the delineation in clear mathematical terms of what had remained hazy generality or metaphysical speculation is of paramount importance"; and, by calling attention to what our philosophers have tried to do, you have enabled every engineer to realise how futile their attempts have proved! An Oxford Don told me quite recently that not more than three or four persons in the world could understand a really clever man; which is probably true; but it does not follow that whatever we do not understand must be the work of a very clever person. Yet that is what Lorentz, Einstein and Minkowski would have us believe; and any of your readers who is interested in their work should read "Das Relativitätsprinzip," some 90 pages of classical papers published, with portrait of Minkowski, by Teubner, of Leipzig, in 1913, at 3 marks.

Hermann Minkowski says: "From this time forth space and time apart from each other are become mere shadows, and only a kind of compound of the two can have any reality"; and it is possible for any plain man of moderate intelligence to show what humbug the whole thing is by merely trying to make sense of what is, after all, but a meaningless jingle of words such as hypnotise some people.

One of your correspondents referred to an essay in the *Philosophical Review*, and this is how it starts: "The principle of relativity is a mathematical principle by which spatial and temporal measurements are co-ordinated for observers in systems of reference which are in movement relatively to one another, and by which the equations are transformed when the observer passes from one system to another. Before we can understand the principle it is essential to understand the problem. Let us suppose that while we are seated in a room some genie, like the genie of the lamp in the story of Aladdin, were to transport the room at a high velocity to some other part of the world, . . . or, let us suppose that it is not the room itself, but the whole solar system which has suddenly started a movement through space at an enormous velocity, impelled, we may imagine, by the kick of some Micromegas at play in the universe."

Need I go on with such stuff? To read it may not help to win the war, though it will raise a smile and perhaps take away our thoughts from morbid subjects and so justify the writing of nonsense; but the author of the essay from which I have quoted is seriously minded, for, at the end, he says: "There must be something absolute, and if the theory of relativity is true this is not space and time, nor any physically real entity fixed in relation to them. If continuity is not to be found in a physical principle it must lie in a spiritual principle. The principle of relativity therefore has an important metaphysical implication."

Thus we get back to ghosts or psychical research or occultism—in fact, to anything but engineering; and we miss "the delineation in clear mathematical terms" which you, Sir, rightly consider to be of paramount importance.

Your obedient Servant,
"A THINKER."

September 2, 1916.

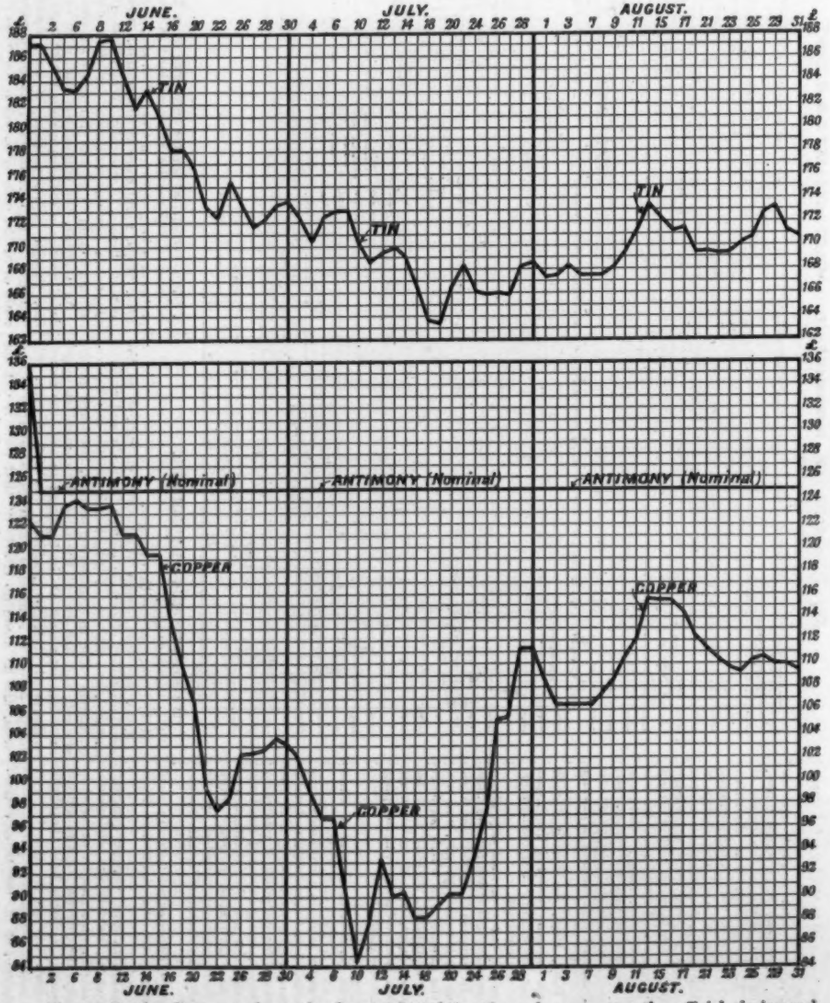
P.S.—In great humility I would refer those interested in *time and space* to a letter of mine which you kindly allowed to appear some two or three years ago.

MINISTRY OF MUNITIONS ORDER.—In pursuance of the powers conferred upon him by Regulation 30 (A) of the Defence of the Realm (Consolidation) Regulations, 1914, the Minister of Munitions hereby orders that the war material to which the Regulation applies shall include war material of the following classes and description, namely:—All machine tools and machinery driven by power and suitable for use in cutting, stamping or working metal, including: Lathes, milling machines, drilling machines, planers, shapers, screw machines, chucking machines, boring machines, slotting machines, grinding machines, boring and turning mills, power presses, punching and shearing machines, forging machines, cutting-off machines, gear-cutting machines, centering machines. The Minister of Munitions gives notice (1) that he hereby permits all persons until further notice to purchase or enter into negotiations for the purchase of the war material referred to in the above Order. Provided that such purchase or negotiations are from or with a person holding a special permit from the Minister to sell such war material and not otherwise; (2) that he hereby permits the insurance of any such war material. All applications for a special permit in connection with the above Order should be addressed to the Director of Machine Tools, Armament Buildings, Whitehall-place, London, S.W.

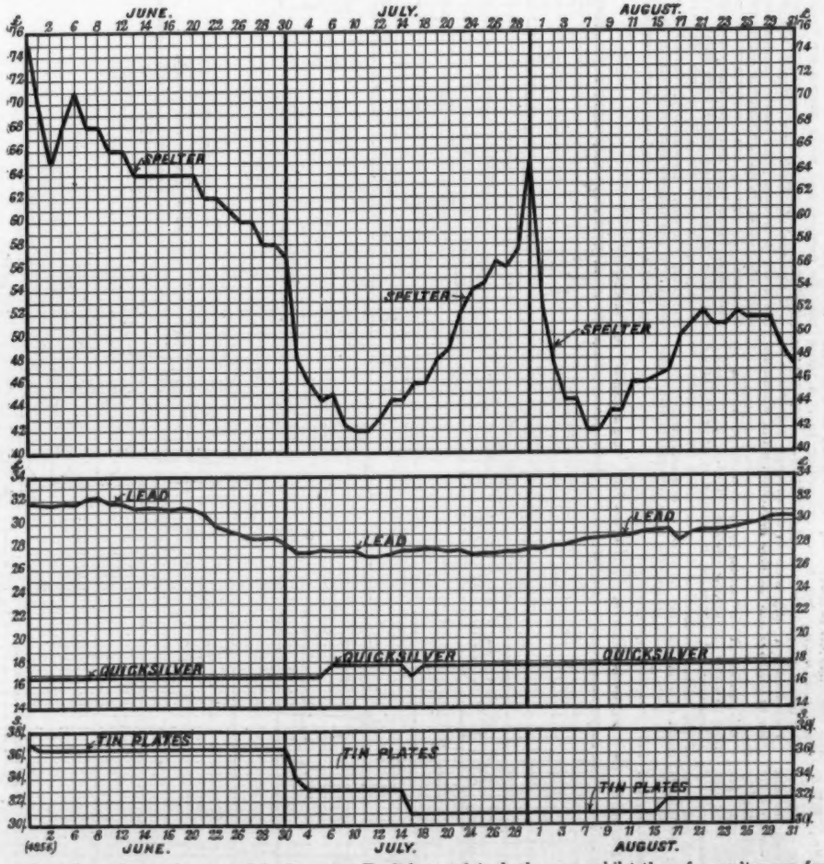
THE INSTITUTE OF METALS.—The following is a list of the papers that are expected to be submitted at the meeting of the Institute of Metals to be held at the Chemical Society, Burlington House, Piccadilly, W., on Wednesday, September 20, 1916, commencing at 4 p.m., and continuing at 8 p.m.:—1. "The Allotropy of Silver." By Dr. W. D. Helderman (Utrecht University, Holland). 2. "Note on Cadmium in Spelter," by W. R. Ingalls (New York, U.S.A.). 3. "The Annealing of Arsenical Brass containing 61 and 62.5 per cent. of Copper. A study of the Structure and Properties developed by varying the Rate of Cooling within the Transformation Range," by C. H. Mathewson and E. M. Thalheimer (Yale University, U.S.A.). 4. "The Development of the Spelter Industry," by Ernest A. Smith, A.R.S.M. (Sheffield). The Government Research Council, having made a grant of 1,000*l.* per annum towards the cost of carrying on the research inaugurated by the Institute of Metals Corrosion Committee into the causes of the corrosion of marine condenser tubes, it has been found possible by the Corrosion Research Committee, which has recently been re-constituted so as to include representatives of all bodies interested in the subject, greatly to extend their sphere of activities. Two salaried investigators have been appointed in the persons of Captain G. D. Bengough, D.Sc., and Dr. O. F. Hudson. They will conduct scientific researches on the committee's condenser plant now about to be installed by the courtesy of the Brighton Corporation in the Brighton Electricity Works. The plant will be worked under ordinary industrial conditions, the microscopical and other examination of the metal treated at Brighton being carried out in the metallurgical laboratories of the Imperial College of Science and Technology, South Kensington.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN PRICES OF METALS.

(Specially Compiled from Official Reports of London Metal and Scotch Pig-Iron Warrant Markets.)



NOTE.—In the diagrams above the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange for "fine foreign" and "standard" metal respectively. The



prices shown for antimony and lead are for English metal in both cases, whilst those for spelter are for American metal. The prices are per ton, but in the case of quicksilver, however, the price is per bottle, the contents of which weigh about 80 lb.; the price of tin-plates is per box of I.C. cokes free on board at Welsh ports. Each vertical line in the diagram represents a market-day, and the horizontal lines represent *l.* each, except in the case of the diagram relating to tin-plates, where they represent 1s. each. On July 7 the Minister of Munitions issued a list of maximum prices and regulations governing the dealing in certain metals, &c.; thus the price of hematite pig was fixed at 6*l.* 2s. 6d., Scotch at 5*l.* 14s., and Cleveland at 4*l.* 11s. 6d. per ton. Ship-plates were priced at 11*l.* 10s., and heavy steel rails at 10*l.* 17s. 6d. per ton. These quotations are still in force. The official regulations were printed in full on page 45 of our issue of July 14 last.

NEW AMERICAN LINES.—The new Finnish-American line has already commenced operations, inasmuch as the company has bought the large cargo steamer Atlantroden, belonging to the Navigator Company. The building of a passenger steamer has been contracted for, but the company can, of course, not commence sailing their vessels till the close of hostilities. Holland, also, is about to start a new steamer line from Rotterdam to New York, and the Greek steamer Macedonia has been purchased.

INTERNATIONAL TABLE OF ATOMIC WEIGHTS.—The annual report for 1916 of the International Committee on Atomic Weights is this year again signed only by Professors F. W. Clarke (Washington), T. E. Thorpe (Salcombe, South Devon), and G. Urbain (Paris). The only change proposed is to adopt the value Cb = 93.1 (instead of 93.5) for the atomic weight of columbium on the strength of the re-determination by Edgar F. Smith and W. K. van Haagen. Columbium is known on the Continent under the name of niobium and stands between vanadium and tantalum. Not much important analytical work has been done during the past year. Noteworthy is the redetermination of the combining weights of hydrogen and oxygen by F. P. Burt and E. C. Edgar, which agrees well with former determinations; the resulting value for the atomic weight of hydrogen is 1.00772 (oxygen = 16); the International Table recommends 1.008, as before. Further, the determination of the density of argon by H. Schultze, which yields the atomic weight A = 39.945; the accepted value is 39.88.

LIMIT GAUGES.*

By R. T. Glazebrook, C.B., M.A., D.Sc., F.R.S.

The fundamental idea of limit gauging—that the dimensions of a piece of work should lie between certain definite values and that the engineer should possess some means of measurement which would enable him readily to tell if this was the case—is probably quite old. Its importance, owing to the growth of repetition work and the demand for interchangeability, has increased greatly of late; during the past two years the growth has been enormous. The work of the Engineering Standards Committee in this, as in many other branches of engineering industry, has been of the utmost value, and it is to the reports of that committee we turn for much of the information on the subject.

It is impossible to speak on this subject without reference to the two men, whom we have recently lost, whose labours did so much to promote the cause of standardisation. Sir H. F. Donaldson was chairman of the Committee on Gauges from its commencement. He threw himself into the work with all the energy of which he was capable; his tact and experience steered the committee over many shoals, his wide knowledge was of the greatest value, and his fairness and courtesy endeared him to all his colleagues. In all he did he was most ably supported by Mr. Leslie Robertson. Only the men who have been intimately acquainted with Mr. Robertson's work for the Standards Committee can realise the greatness of his loss and the difficulty of finding one to fill his place.

Report No. 27, dated June, 1906, deals with British Standard Systems for Limit Gauges (Running Fits), and was the result of much careful inquiry and discussion. From it is taken the following definition:—

"*Limit Gauges.*—Gauges for ensuring that any given dimension is within the tolerance laid down for the class of work to be produced. In the case of cylindrical work these gauges may be either double male gauges, one end of which *must* enter, and the other end of which *must not* enter the hole to which it is applied, or they may be either two-ring or two-gap gauges, one of which *must* pass over, and one of which *must not* pass over the plug or male piece to which they are applied."

And the report continues:—

"The committee have in view three classes of limit gauges, viz.:

"(a) *Standard Limit Gauges* made in accordance with the recommendations contained in this report, and with the greatest possible accuracy, for depositing with the National Physical Laboratory, for purposes of reference.

"(b) *Reference Limit Gauges*, being copies of the foregoing Standard Limit Gauges for use by manufacturers and others for checking their own shop gauges. They should be verified, and their accuracy certified by the authority in whose custody the Standard Limit Gauges are deposited.

"(c) *Shop Limit Gauges.*—The gauges actually used in the shop and checked against the Reference Limit Gauges."

To this list it is desirable to add "check gauges," i.e., gauges designed to check readily the dimensions of gauges in use either as reference gauges or as shop gauges. These are usually the inverse of the gauges they are employed to check, *i.e.*, for a hole the check gauge is a plug, and *vice versa*.

* Paper read before Section G of the British Association at Newcastle, September 6, 1916.

I propose to say something about these various classes of gauges—their use, the permissible limits of accuracy, and the methods of measuring or otherwise determining their dimensions; but before proceeding to this three other terms in common use need definition. These are:—

Tolerance.—A difference in dimensions prescribed in order to tolerate unavoidable imperfections of workmanship.

Allowance.—A difference in dimensions prescribed in order to allow of various qualities of fit.

Clearance.—A difference in dimension or in the shape of the surface prescribed in order that two surfaces or parts of surfaces may be clear of one another.

In dealing with gauges we may sub-divide them usefully into three groups:—

(I) Gauges for plain cylindrical work.
(II) Screw gauges.
(III) Form and position gauges.

Years ago Sir Joseph Whitworth embarked on the standardisation of certain gauges for plain and screwed surfaces, and the use of Whitworth gauges has been of enormous value to engineering science, but these gauges are not, and had not at the time the committee began its work, been used as limit gauges in the true sense; consequently interchangeability was not secured. Sir Joseph aimed at standards which should be true dimensions, and he made no effort—at that time it did not appear necessary—to specify plus or minus limits for each class of work. Accordingly, at the outset the committee were faced with the necessity of inquiring what should be the limits on the work in order that interchangeability may be secured and what gauges are required for this purpose.

I. *Cylindrical Work and Gauges.*—In dealing with the work it is clear that the tolerances and allowances must depend on its nature and the class of fit aimed at; different allowances are necessary for running fits, push fits, force fits, &c. In the year 1906 the data available to determine these were small. Accordingly, arrangements were made by which Mr. Attwell, of the National Physical Laboratory, visited the workshops of many of the leading manufacturers of the country and, by their kindness, carried out the accurate measurement of plain cylindrical shafts and holes from 2 to 12 in. in diameter. The results are contained in the tables and plates of a long report of the E.S.C. (No. 25) dated July, 1906. Figs. 1 and 2 are an illustration. Certain firms—notably Messrs. Armstrong, Whitworth—had already adopted a system of limits for their own use, and information on these was also before the committee.

As a result, the committee were able to draw up a definite series of recommendations with regard to running fits, though before reaching a final decision another difficulty had to be faced. Are the dimensions of the shaft or of the hole to be made the basis of the work? With an inch shaft, for example, is the shaft to be made

Fig. 1. ERRORS IN WORKMANSHIP. SHAFTS. CLASSES (B) AND (C)

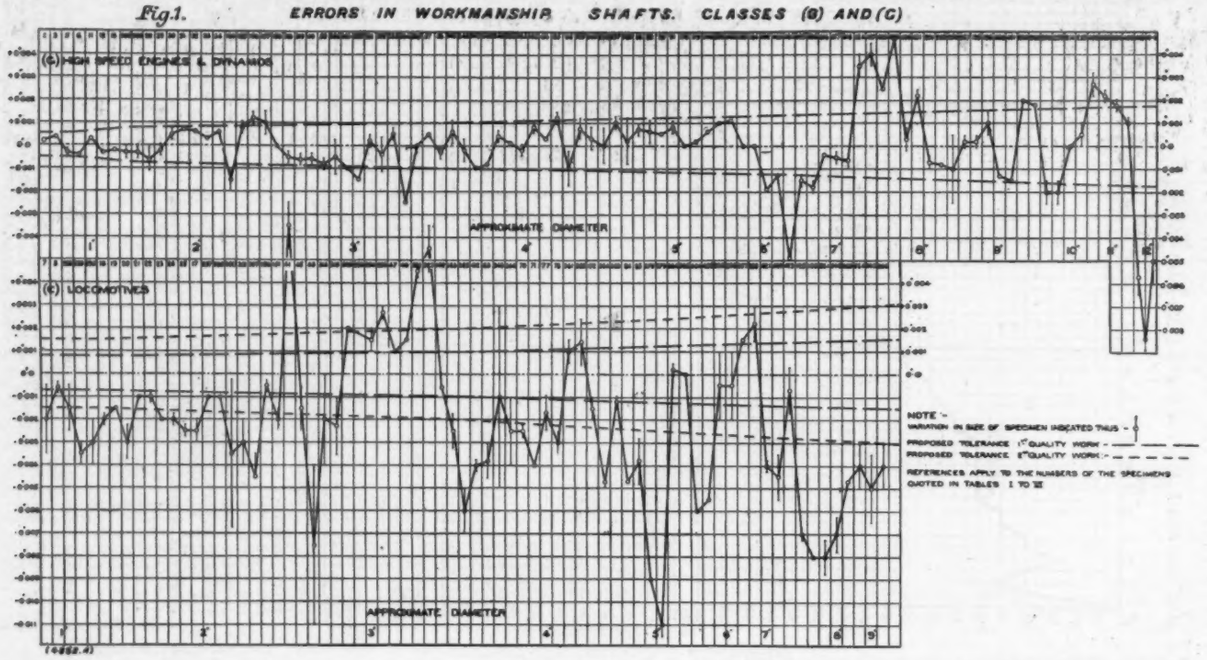
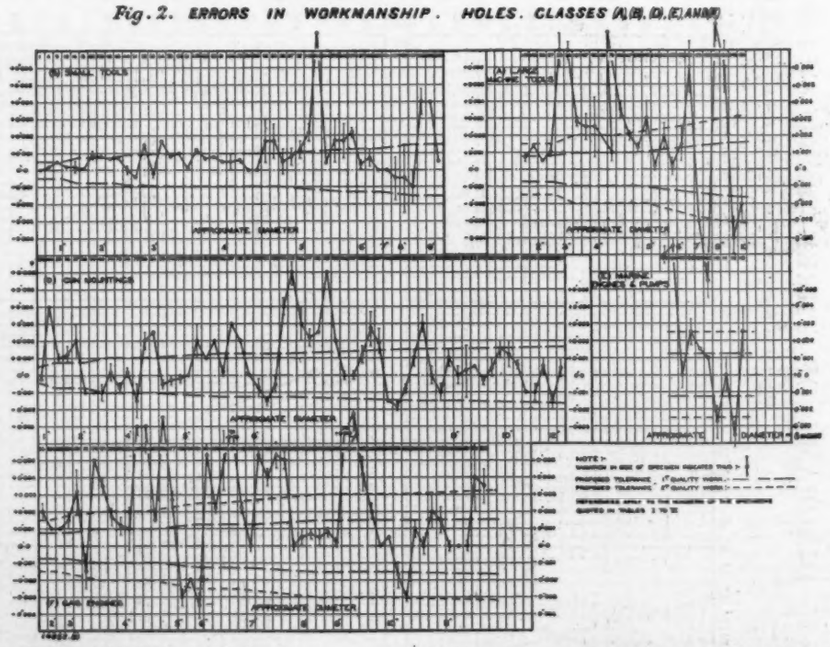

(B) HIGH SPEED ENGINES & DYNAMOS
APPROXIMATE DIAMETER
(C) LOCOMOTIVES
APPROXIMATE DIAMETER
NOTE:-
VARIATION IN SIZE OF SPECIMEN INDICATED THUS -
PROPOSED TOLERANCE (1ST QUALITY WORK) -
PROPOSED TOLERANCE (2ND QUALITY WORK) -
REFERENCES APPLY TO THE NUMBERS OF THE SPECIMENS QUOTED IN TABLES I TO III

Fig. 2. ERRORS IN WORKMANSHIP. HOLES. CLASSES (A), (B), (D), (E) AND (F)

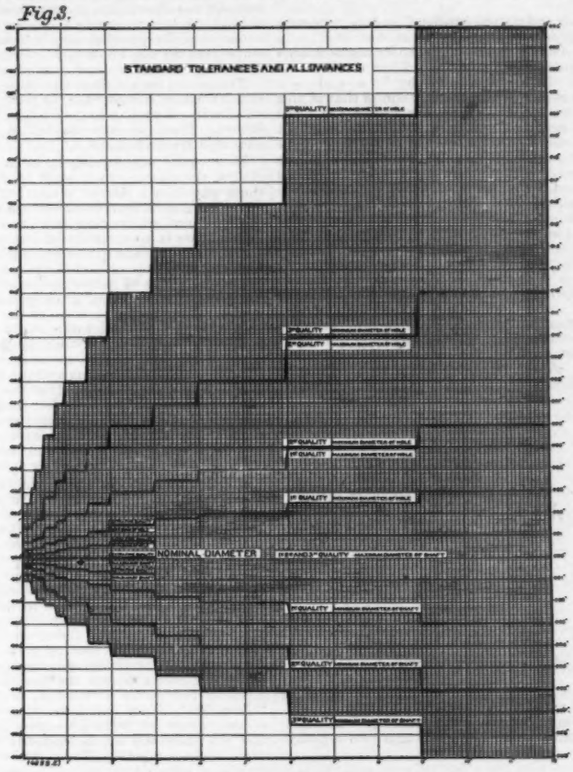

(A) SMALL TOOLS
APPROXIMATE DIAMETER
(A) LARGE MACHINE TOOLS
APPROXIMATE DIAMETER
(B) HIGH SPEEDS
APPROXIMATE DIAMETER
(E) MARINE ENGINES & PUMPS
APPROXIMATE DIAMETER
(F) GUN BORES
APPROXIMATE DIAMETER
NOTE:-
VARIATION IN SIZE OF SPECIMEN INDICATED THUS -
PROPOSED TOLERANCE (1ST QUALITY WORK) -
PROPOSED TOLERANCE (2ND QUALITY WORK) - - - - -
REFERENCES APPLY TO THE NUMBERS OF THE SPECIMENS QUOTED IN TABLES I TO III

as nearly 1 in. as possible with only the necessary tolerance, and the whole of the allowance to secure the running fit to be made in the hole, which is therefore of necessity larger than 1 in. by the amount of this allowance; or is the reverse course to be adopted? In the end the committee adopted the view that wherever possible the shaft should be the element more nearly approaching the true dimension and allowance be made on the hole according to the kind of fit required. The tolerances on the shaft are negative, so that it may never exceed its nominal dimensions. A minimum allowance, obtained by making the hole of larger than nominal allowances applied to the shaft, the minimum diameter of the hole being its nominal size. The results of this part of the committee's work are shown in Fig. 3.

It will be noted that, with a view to reducing the number of gauges required, the scheme has been arranged so that the maximum diameter of the hole for first-class work is the minimum for second-class work, and so on. Assuming now agreement has been reached as to the allowances and tolerances on the work, what as to the gauges?

For a shaft we require two gauges—two rings or snap gauges as may be preferred—one corresponding to the

Fig. 3.



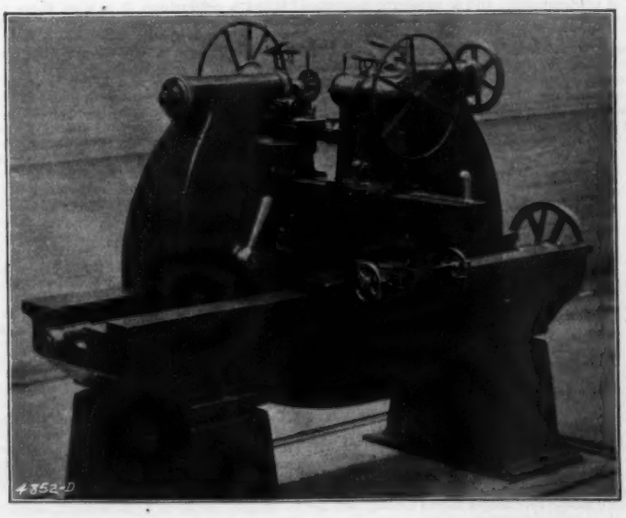


FIG. 4.

size, is specified, and this cannot be encroached upon by either element; above this a positive tolerance is allowed on the hole.

For example, in the case of a 5-in. shaft and hole of first class work, the tolerance on the shaft is 0.002 in. Thus it must lie between 5.000 in. and 4.998 in. The allowance is also 0.002, so that the minimum diameter of the hole is 5.002 in. On this there is a tolerance of 0.002 in. again, hence the hole may have a maximum diameter of 5.004 in. This system the committee call the "shaft" basis; they note, however, that the system may be reversed, the hole being taken as basis and the maximum or high dimension, the other to the minimum or low dimension, and, as perfect workmanship is impossible, these gauges must be subject to tolerances; what is to be said as to the sign and amount of the tolerances? And here a distinction has to be noted. So long as the work is within the limits allowed, interchangeability is secured, and it will pass inspection. In fairness, however, to the manufacturer, all work up to the limits should pass; the inspection gauges should not demand narrower limits than the production drawings. Accordingly, the tolerances on a high inspection gauge must be positive, those on a low inspection gauge negative.

This is a point which the gauge maker should carefully attend to. He knows, maybe, that the nominal size of a certain high gauge is 2.000 in. with a tolerance of 0.0005 in.; he should try, then, to make his gauge 2.00025 in. In many cases the attempt is made to produce the gauges as nearly as possible 2.000 in., and some are made a trifle too small; they are rejected, necessarily: had their aim been to arrive at 2.00025 in., probably all would have got through when tested.

So far, then, we have found that for an inspection gauge the tolerance is positive on the high gauge, negative on the low. But in the workshop gauge, as will be seen, the reverse is the case. These are given out by the manufacturer to the workman to enable him to make work which will pass the inspector. Clearly, then, for safety he will arrange that the limits to which the man works are rather narrower than those to which the work will be inspected. A high gauge will be a trifle too small, a low gauge slightly too large; the tolerance on the high gauge is negative, that on the low gauge is positive.

As to the tolerances permissible, these depend on the class of work dealt with, and for inspection gauges amounts of the order of one-tenth of the tolerances on the work are not unusual. Thus, for the 5 in. shaft of first-class work already referred to, the high gauge would lie between 5.000 in. and 5.0002 in., the low gauge between 4.998 in. and 4.9978 in. These, of course, are close limits. For a workshop gauge, the tolerances, as well as being of opposite sign, may wisely be large in amount; the result of this is to contract somewhat the limits within which the workman has to work, but to

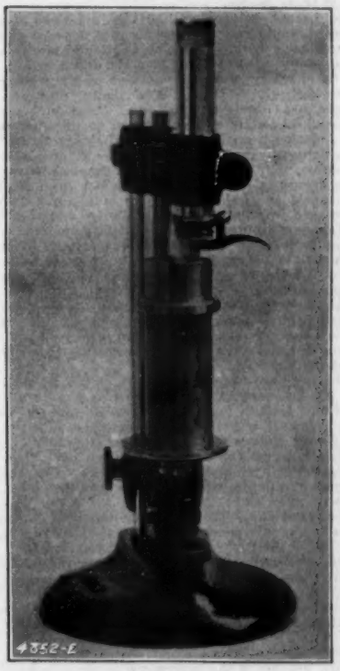


FIG. 5.

increase the chance that his work will pass. Moreover, the "go" gauges wear, and a ring or a plug may easily in time become too large or too small respectively if, when new, they are very close to their nominal sizes.

In our original classification of gauges, reference gauges were mentioned. These clearly include both reference inspection gauges and reference shop gauges; they are retained for the purpose of standardising the other gauges.

We turn now to the measurement and testing of cylindrical gauges. For the purpose of merely testing a gauge to see if it is correct, two check gauges—a "go" and a "not-go"—may be used, and in some cases must be used. The difference between these will be equal to the tolerance on the gauge they are used to check and their own tolerances will be much smaller, but for cylindrical gauges in most cases check gauges are not necessary and indeed are not desirable; the difficulties arising from inaccuracy of manufacture and wear are too serious. Besides, rejection by a check gauge gives no intimation of the error to the manufacturer, and thus it is unsatisfactory to him. Thus cylindrical plug gauges are preferably checked by some form of accurate micrometer or measuring machine. To describe such machines in detail would fill a paper by itself; it must suffice to mention one or two leading points.

The original Whitworth form depends on the use of a feeler, a bar which is passed down between the jaw of the machine and the gauge under test, and while high accuracy can be attained by practice the results are slow and depend on the skill of the observer. In another form, a plunger presses against a spring and tilts a delicate level. The micrometer is turned until the

bubble is central, thus securing that the pressure applied to the gauge is always the same; the importance of this is very great. It has been found useful at the National Physical Laboratory to replace the level by a tilting mirror; the machine is in adjustment when a ray of light reflected from the mirror occupies a definite position on a suitably placed scale.

Fig. 4 is a photograph of a large machine built to the laboratory design by Messrs. Armstrong, Whitworth, in which this device is used. It is employed to measure large cylindrical gauges, and was built for the measurement of the coils of some of the standard electrical apparatus (page 237).

Fig. 5 shows another instrument in regular use for testing smaller cylindrical gauges. A vertical plunger pressed downwards by a spring actuates a light lever moving over a scale; below is a horizontal platform with a slow vertical motion. A standard gauge of the required dimension is placed on the platform, which is raised until the upper end of the gauge pressing on the plunger brings the lever to the centre of the scale; the standard is then removed and its place taken by the gauge under test. The difference between this and the standard is given by the position of the pointer on the scale. In another instrument of this class the motion of a diaphragm raises or depresses a column of liquid in a fine tube.

All these methods demand the employment of accurate standards of a large variety of lengths. Such are afforded by the now well-known Johanssen gauges. By means of these, length gauges differing in length by one or more thousandths of an inch can be built up with an accuracy amply sufficient for checking gauges to under the one ten-thousandth, and most of the test work at the National Physical Laboratory is now done by the aid of these gauges.

To discuss the problem how the Johanssen gauges are checked would carry us too far into detailed consideration of such work, while how to make them is a secret many would wish to share with Mr. Johanssen.

The checking of ring gauges or of snap gauges is a more difficult problem. For many purposes check gauges are used—a "go" and "not-go" plug, the external diameters of which can be accurately measured, and indeed for small rings this is the only method. For larger gauges there are various forms of internal callipers available, but these do not lend themselves readily to high accuracy. A method which has been found convenient at the Laboratory is to build up a "go" and "not go" internal diameter gauge by means of a series of Johanssen gauges with two plain cylinders of known diameter, one at each end of the series. When once such a diameter gauge has been put together, the checking of a series of rings of the same diameter becomes a simple matter.

II. *Screw Gauges.*—The problem of the standardisation of screw limit gauges is a very difficult one; a screw surface is a complex form, and to satisfy oneself that in all its dimensions it lies within certain limits involves much careful work.

The question is fully discussed in the E.S.C. Report, No. 38, February, 1913, on "British Standard Systems for Limit Gauges for Screw Threads," and the following definitions are taken from the report:—

Effective Diameter.—The effective diameter of a screw having a single thread is the length of a line drawn through the axis and at right angles to it, measured between the points where the line cuts the slopes of the thread. (Fig. 6*a*.)

Core Diameter.—The core diameter is twice the minimum radius of a screw, measured at right angles to the axis. (Fig. 6*a*.)

Full Diameter.—The full diameter is twice the maximum radius of a screw, measured at right angles to the axis. (Fig. 6*a*.)

Crest.—The crest is the prominent part of the thread, whether of the male screw or of the female screw. (Fig. 6*b*.)

Root.—The root is the bottom of the groove of the thread, whether of the male screw or of the female screw. (Fig. 6*b*.)

Slope of Thread.—The slope of thread is the straight part of the thread which connects the crests and roots. (Fig. 6*b*.)

Angle of Thread.—The angle of thread is the angle between the slopes, measured in the axial plane. (Fig. 6*b*.)

NOTE.—From Fig. 6*a* it will be seen that the "core diameter" of the male thread is measured between the roots of the thread; it should be borne in mind, however, that the "core diameter" of the female thread, being approximately the same dimension, is measured between the crests of the thread.

Pitch.—The pitch is the distance in inches measured along a line parallel to the axis of the screw between the point where it cuts any thread of the screw and the point at which it next meets the corresponding part of the same thread. (Fig. 6*b*.) *The reciprocal of the pitch* measures the number of turns per inch or millimetre, as the case may be.

In the Whitworth thread standardised by the committee there are seven elements, and error in any one of these may be sufficient to cause a gauge to reject work which ought to pass, or *vice versâ*. These elements are as defined already:—

Full (or major) diameter.
Core (or minor) diameter.
Effective (or pitch) diameter.
Pitch.
Angle.
Form at crest.
Form at root.

Of these, the most important and the most difficult to control are the pitch and the effective diameter.

In the Whitworth thread the attempt is made to obtain contact over the whole surface of the screw; while possibly for some purposes this is desirable, it adds greatly to the difficulties of both construction and gauging, and there is much to be said for a system which allows definite clearances at crest and root. Four of the above seven elements—the first two and the last two—then become unimportant, and we are left to concentrate on the effective diameter, the pitch, and the angle of the thread. If the screw bears along its slopes it is doing its work satisfactorily, and in most cases the fact that there is clearance at crest and root is immaterial.

Before proceeding further it is important to notice that errors in pitch and effective diameter are closely connected.

Suppose the full and dotted outline, Fig. 7, to represent a ring and a plug screw of similar form, but of slightly different pitch. Let the maximum relative displacement of any two threads engaged be $2a$. Then the extreme threads will be displaced axially by $+a$ and $-a$ respectively. A glance at the diagram shows that in this case the parts will not go together unless the axial displacement is accompanied by a radial displacement which, allowing for the angle of the thread, is about equal to $2a$. This is doubled on the diameter, so that as a rough rule it may be taken that any error in pitch has to be compensated by an error of twice the amount in effective diameter.

Thus we can compensate for an error p in pitch on a thread of which t in. are engaged by allowing a reduction of effective diameter of $2\,p\,t$ in the plug, or an increase of the same amount in the ring. Some reductions in the full and core diameters are also required, but in consequence of the curves at crest and root these are small and need only rarely be taken into consideration. Reducing the effective diameter of a plug, or increasing that of a ring screw, has the effect of reducing the thickness of the corresponding thread at that point; the thread is made thin. Thus, in order to compensate pitch errors, makers have a tendency to make their screws

Fig. 6a.

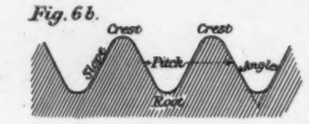


Fig. 6b.

Fig. 7.

thin; they claim an allowance on effective diameter which makes up for the error tolerated on pitch.

The Engineering Standards Committee, in their report, No. 38, state that they have had two separate matters to decide upon:—

"1. To lay down tolerances on full, core and effective diameters to cover the wear of tools and unavoidable imperfection of workmanship, and to prescribe minimum allowances in order that bolts and nuts may be assembled freely.

"2. To decide what errors in pitch could be permitted in ordinary practice, having regard to the allowances in effective diameter which they entail."

And as a result they recommended a series of tolerances for the two threads considered—British Standard Whitworth and British Standard Fine—given by the following formulae taken from report No. 38 of February, 1913:—

Bolt. Tolerance on Full Diameter.	Bolt. Tolerance on Core Diameter.	Allowance (on the Nut).	Nut. Tolerance on Full and Core Diameters.
B. S. W. Threads.			
1.	2.	3.	4.
in. $-0.0035\sqrt{D}$	in. $-0.0045\sqrt{D}$	in. $+0.001\sqrt{D}$	in. $+0.0035\sqrt{D}$ (above allowance)
B. S. F. Threads.			
5.	6.	7.	8.
$-0.0025\sqrt{D}$	$-0.0035\sqrt{D}$	$+0.001\sqrt{D}$	$+0.0025\sqrt{D}$ (above allowance)

D = nominal diameter of thread in inches.
The positive and negative signs refer to the nominal dimensions of the bolt.

The report also gives the formulæ for the tolerances on pitch and the allowances on effective diameter required to compensate them, and tables setting out the tolerances on the various elements.

(To be continued.)

PRESIDENTIAL ADDRESS TO SECTION G, BRITISH ASSOCIATION.*

By GERALD STONEY, B.A.I. (Dub.), F.R.S., M. Inst. C.E.

AT times such as these the mind naturally turns to problems to be considered both at the present time and after the war, and in considering such problems a review of some of the errors committed in the past is most necessary. Such a review enables methods which should be adopted both now and in the future to be considered. As this is an address to the Engineering Section of the British Association for the Advancement of Science, only such problems will be considered as affect engineering and its allied industries.

One thing which has handicapped our industries is the reluctance of firms to utilise highly educated labour or to adopt scientific methods. In looking round the industries of most districts one is struck by the small number of men who have undergone a thorough scientific training at one of the universities or at a leading technical college, and who occupy a prominent place in the firms.

The general complaint is that university and college men are too theoretical and not practical. It is the usual thing for a bad workman to blame his tools, and in this connection the question may be asked: Is it not because employers do not know how to make use of such labour that they utilise it to such a small and imperfect extent?

Things are very different in some other countries with which we have competed in the past, and with which there will be in all probability still fiercer competition in the future. There we find the fullest use made of highly-educated scientific labour.

How many engineering firms in this district have a skilled chemist on their staff, and what percentage of these pay him a decent salary? How many heads of firms have sufficient chemical knowledge to appreciate the work and utilise the services of such a man, because unless there is appreciation of the work done by him his services are useless and he becomes discouraged, generally finding himself up against the blank stone wall of passive tolerance, if not of active prejudice. And yet chemical problems are continually cropping up in engineering work. There is the question of the supply of materials; as a rule the manufacturer trusts to the name of the contractor and assumes that he gets materials of the composition and purity he ordered. Every now and then something goes wrong and the question arises, why? Without a chemist to analyse the material it is often most difficult to say. Apart from this necessity for analysis of raw or partly manufactured materials received, there is the chronic question as to the mixtures of the metals in both the metal and brass foundry. Large economies can be effected by systematic analyses.

Another direction in which scientific work is invaluable is in seeing that instruments are in proper order and that tests are accurately carried out. Tests carried out with inaccurate instruments, and without proper scientific precautions to see that they are accurate and reliable, are worse than useless, and, in fact, most misleading and dangerous, as entirely unreliable inferences may be drawn from them and far-reaching troubles caused in the future. How many tests of steam engines are unreliable because there is no standardisation of the pressure and vacuum gauges and thermometers used, and in how many cases is even the reading of the barometer omitted? An absolute pressure stated as so many inches of vacuum has no meaning unless the barometer reading is also given or the inches of vacuum is stated as reduced to "Bar. 30." How many firms using steam have any arrangements for testing vacuum and pressure gauges, and yet there are no instruments more liable to error than these gauges? When one tries to analyse the results of steam tests one is constantly up against the elementary question "Were the gauges, &c., accurate? What a misfortune it is that there were no means of testing their accuracy." Under scientific supervision arrangements are made to avoid such troubles and get reliable results which can be depended on for future designs.

What has been said about pressure gauges and the measurement of pressure applies, of course, to all other instruments and measurements. In most works, it may be said, with sorrow, that the only moderately accurate measurements that can be made are those of dimensions and weight. It is only by accurate testing of existing plant that reliable deductions can be drawn enabling safe progress to be made in future designs.

One of the great things which helped forward the steam turbine in the early days was accurate and full testing of each plant as soon as it was completed and before it left the works. The late Mr. Willans was probably the first, or one of the first, to recognise the importance of accurate testing of steam plant, and the success his well-known engine had was largely due to this. From the earliest days of the steam turbine Sir Charles Parsons recognised the necessity of such testing, and the test house has always been a prominent feature of Heaton Works. And, then, in the higher ranks of an engineering works it requires a scientific mind to draw safe conclusions from tests carried out and to see in what directions progress can be safely made. Such methods have enabled the steam turbine during the writer's acquaintance with it, now extending over some 28 years, to grow in power for a single unit from 50 h.p. to some 45,000 or more, and the steam consumption to be reduced from 40 lb. per horse-power-hour to about 7½ lb., or less than one-fifth.

Closely allied to such work in engineering factories is the general question of scientific research, and here a trained scientific mind is of the utmost importance to see that reliable results are obtained and to make true logical deductions from those results. Without suitable training a man is liable to be unable to grasp all the conditions of an experiment and is apt to make deductions from the data obtained which are totally unjustified and often lead to most disastrous results in the future.

Such research is generally carried out in four places—engineering works, private laboratories, engineering colleges, and national laboratories.

The first has already been dealt with.

The second is of comparatively small importance in practice.

As regards the third a great deal of good work has been

* Delivered on September 6.

done in engineering colleges, often under great difficulties owing to want of plant and money, and it is greatly to the credit of our professors and others that they have succeeded in doing so much with the very inadequate appliances at their disposal, and handicapped for want of funds. How inadequate their income is can be understood when it is remembered that Leipzig University alone has an annual income from the German Government of 100,000*l.*, as against a total Government grant to *all* the Universities here of about 45,000*l.*, or less than half.

Of national laboratories we have only one, the National Physical Laboratory at Teddington, and here, again, the support given to it is totally inadequate. The total income from all sources last year was only 40,000*l.*, and of this 23,000*l.* was in payment for work done, such as testing meters and other instruments and other commercial work; the Government grant is only 7,000*l.* a year, and besides this 7,500*l.* was received for experiments in connection with aeronautics, which is really war work. The balance was made up of subscriptions, grants from technical societies, and miscellaneous receipts. Compare this with the German equivalent, the Reichsanstalt of Berlin, which has an income of 70,000*l.* a year from the Government, or 10 times that given to our National Physical Laboratory. The Bureau of Standards, the similar institution in the United States of America, has a Government grant of 140,000*l.*, or 20 times ours. In the Civil Service Estimates there is an allowance of 40,000*l.* for research, an increase of 15,000*l.* over that allotted last year (4*s.* for each 100*l.* of the Civil Service Estimates). The total estimates are over 20,000,000*l.*, so that less than one-fifth per cent. is allotted to research.

It is difficult to realise what benefits might be gained by investigations which could be carried on by the National Physical Laboratory if only sufficient funds were available, and of what importance they might be to industry at large. One example may suffice. Some time ago the Reichsanstalt carried out a most complete set of tests on a certain class of machine, an investigation which must have cost several thousands of pounds sterling, apart from the time it occupied. The results of this investigation are available to German manufacturers of this machine; just before the war preparations were being made to take advantage of this, and from figures stated a large extra economy was expected. This, of course, would enable them, provided the cost of manufacture was not too high, to have an enormous advantage over such machines manufactured without this special knowledge. The Institution of Mechanical Engineers saw the importance of this problem and appointed a research committee to deal with the question, but the first question met with is that of finance. Should this be the case in a wealthy country such as ours, which depends on its manufactures for its very existence? And that such an investigation is required is obvious from the fact that the designs of no two independent manufacturers of this machine in this country agree among themselves. Of course, each claims his is the best, but this cannot be so.

Investigations in engineering shops do not meet such a case. The question of finance has to be carefully watched, and as soon as results sufficiently good are obtained they are generally accepted, and in any case the problem is rarely thrashed out to the bottom, an almost universal defect in commercial research work. Without the help of the National Physical Laboratory the position of the aeroplane in this country would be very different from what it is, and what has been done for the aeroplane requires to be done in many other directions.

But what firm here would do what has been done in the commercial synthesis of indigo, on which it is said that 17 years' work and over 1,000,000*l.* has been spent by one firm alone abroad. Here in chemical investigations and manufactures the Government refuse even to give the help of allowing cheap alcohol to be obtainable, and much of such work is impossible in this country on this account, as in many cases methylated and denatured alcohol are not suitable. Recently under pressure the restrictions have been somewhat relaxed by the Government, but many manufacturers have found that the privileges granted are so tied up in red tape that the concessions are practically useless.

It is not only on the scientific side that there is so much to be done in the way of putting our house in order; there is much to be done in the way of putting the management and commercial sides of engineering and other allied works in a position to compete successfully with foreign countries.

The great growth of engineering firms and their formation into limited liability companies has not been without its drawbacks.

In the old days an engineering works was comparatively small and, as a rule, one man, generally a clever engineer, was at the head. After his death, and often before, the place was turned into a limited liability company, and gradually fell into the hands of a body of men, many of them not technical, who had no further interest in the firm than to draw their salaries as directors and managers, and who had no financial stake in the concern beyond the 500*l.* or 1,000*l.* in shares necessary to qualify them as directors. The result is that the place gradually degenerates, initiative ceases, and it finally gets to a stage of not paying any dividends, and really being kept going, not for the sake of the shareholders, but of the directors and other officials.

Such a firm as a rule does not put enough aside for depreciation, and thus its machinery and buildings degenerate and become obsolete, which makes it still less able to compete with more modern firms. At the same time it is not able to afford the money necessary to carry on the experimental and research work which is a necessity for any progressive firm, and thus its manufacturers cease to progress with the times. As Sir Charles Parsons truly said, a man or firm in the face of financial difficulties cannot carry on research work. The minimum spent on research work should be at least 1 per cent. of the turnover, and the amount it is advisable to spend is 3 per cent. Unless a firm makes good profits it cannot keep up to date, and will sooner or later go to the wall.

But the workman says that he should have his share. What is his share under the present state of things? The average capital expended in an engineering works per individual employed is about 200*l.* An inquiry the writer made some years ago gave this figure; it was confirmed by an investigation of shipbuilding yards, which gave 185*l.*, and by the Census of Production, which gives a capital of 1,500,000,000*l.* for 7,000,000 workers, or 214*l.* per man. An analysis of the dividends paid shows them to be about 4 per cent. on the capital employed. Here it must be remembered that firms paying 10 to 15 per cent. on their ordinary capital have often a large preference and debenture capital, on which a much lower rate of interest is paid, and also that often part of the ordinary capital was issued at a premium, so that the actual return or dividend is far below the nominal dividend declared on the face value of the share. Account has to be taken, too, of the large number of companies that do not pay any dividend on their ordinary shares, and often none on their preference stock. Little is, as a rule, heard of the finances of such companies; it is the ones paying good dividends that public attention is drawn to.

It thus means that the shareholders get about 8*l.* per year per individual employed.

On the other hand, the average wages for men and boys, skilled and unskilled, is about 70*l.* per annum in normal times. This means that the worker gets between eight and nine times as much as the capitalist. The figures show on what a very small margin the capitalist works. And without the capitalist, under our present system of individualism, there would be no factories erected and run, and therefore no work for the working man, a thing it is well for him to remember. Without profits the capitalist will not invest in engineering and other works in this country, but will seek for a more profitable field for his capital elsewhere. Every 200*l.* invested in this country in a factory means work and livelihood for one British working man.

At the same time I am sorry to say the employer does not look after the welfare of his workmen as he might. In a small factory the head of the firm, as a rule, knows all the leading men among the workmen, many of them having been with him for years. As the place grows he loses touch with his men, and as an actual fact knows fewer of those under him when he has 1,000 or more employees than he did when he had 400 or under. This state of things gets worse when the place is turned into a limited liability company, as nearly all large places are at present. The result is that a most deplorable state of things has come to pass. The workman says, "Put not thy trust in employers"; the master says, "Put not thy trust in workmen," and the official who is between the master and the workman says, "Put not thy trust in either."

It is difficult to say what can be done to remedy this state of things, but one cannot help feeling much might have been done in the past to have prevented such a regrettable state of affairs as there is at present. Much of this trouble might have been avoided if employers had shown more consideration for the welfare of their workmen. Of course, there are some notable exceptions, but they are few and far between. An example is the necessity of the Factory Acts to ensure proper light and air and other arrangements necessary for the health of the workmen. But much more should be done. Why is it that canteens are being rushed up all over the country, and why were there so few before? In many works to this day the provisions for getting food and drink warmed are most primitive and inefficient, and as to getting anything to eat if one has to work overtime unexpectedly, it is in most works impossible. As a rule the only thing available was a drink at the public house outside the gates, and even this is now closed at 5 o'clock. Why if a man works overtime should he also starve? And how can efficient work be expected under such conditions? Why also should there not be provision for drying clothes of a man who has had to walk to work on a wet morning. Each man should be provided with a cupboard where he could keep a change of boots? Why are not sanitary arrangements decently private, and why are they not kept clean and wholesome: they are often in a disgraceful state? These are only a few samples of the directions in which much might be done.

The adjustment of the wages to be paid to the workman is a most difficult one. There are three principal ways of paying workmen: on time, on piece, and on bonus.

On time is the only way of paying a man who is on various classes of work, where the fair time required for each job is not known. In many cases the most highly skilled men are on such work and as a result only make time wages. This results often in the highly skilled man making less money than the less skilled man who is on repetition work, and as a consequence is working on piece or bonus. This is obviously unfair. For example, a man may have the setting up and adjusting of a number of machines on repetition work, and he often makes less money than the less skilled men under him who are on piece or bonus, although their nominal rate of wages is less than his.

Again, highly skilled erectors who go outside the works to erect machinery, often worth thousands of pounds, and set it to work are only paid on time, and often make less money than their fellows who are on piece inside the works.

The adjusting of piece prices is a most difficult one. They should be adjusted so as to be fair both to master and man, but too often such fixing of prices is left to subordinate officials who have in many cases their own axe to grind. There should in every works be a special department for such fixing of prices, and once a price is fixed it should not be altered without good reason. The practice of cutting prices by the masters in the past is, in the opinion of the writer, largely responsible for the present limitation of output by the men about which we hear so much. There is a tendency that if a man makes more than time-and-half or time-and-third the price of the job is cut. If the price has been fairly fixed why should it be reduced because the man makes large wages due to his skill and industry? The larger the output from his vice or lathe the better for the master, as he is getting a larger output from his plant with a certain capital expenditure, and thereby establishment charges are reduced. This is especially the case in machine work, as the hourly value of the machine employed often far exceeds the wages of the workman employed.

A fair rating for machine tools is 4*d.* per hour per 100*l.* value, and as the time rating of the man is generally about 9*d.*, it is easily seen that if the average value of the machine tools exceeds 225*l.*, machine charges exceed time wages, and the average value of machine tools is generally largely in excess of this figure, in fact often about double it. It is therefore obvious that it is much more important to get large output than to pay small wages.

The result of this "time-and-half" rule is that a good man by working up to the limit of his capacity "spoils the job" for the next man who comes along and who may not be of the same calibre as the first man. It has, therefore, been found advisable and necessary by the workmen to limit the output of all men to a certain standard, and this results in the end by the pace being set by the slowest man on a particular job.

A fair bonus system is perhaps the ideal way of paying men, but here, again, although the times for a job are supposed to be fixed and unalterable, in too many cases they have been altered by various devices, and as a result the system is looked on with suspicion by the workmen.

Gradually, bit by bit, the pernicious doctrine has grown up that the less the work done by a man the more employment there will be. The workman does not see that the cheaper an article can be produced the larger will be the sale for it and the better it will be able to compete with the products, not only of other producers in this country but of those abroad. And also that very cheapness, combined with good quality, induces the sale for such articles to be large.

Laziness is inherent in man, and *on an average* no man will work unless compelled to do so, and still less will he work his best unless there is a great inducement. This is true not only of the working man, but of all other classes. Therefore the policy of "Ca' Canny" has been only too readily adopted on the ground not only that it was pleasant for the man himself, but also he believed that it tended to the welfare of his fellow-workmen.

The writer has very reluctantly come to the conclusion that the workman of to-day is not doing as much work as was done some 30 years ago when he was in the shops, and not only this, but that timekeeping is not as good. In this connection, however, it must be remembered that excessive overtime inevitably leads to bad timekeeping. Bad timekeeping causes much more loss than that due to the actual time lost, as not only does machinery and other plant lie idle, but the disorganisation caused in a works by lost time is most serious.

With the growth in strength of the Trade Unions, which at first were for the legitimate object of seeing that the workman got fair play, and providing out-of-work and old-age benefits, &c., has grown up a system of Trade Union officials who live by agitation, and whose job would be gone if there were no supposed grievances to agitate about. These men keep the labour world in a constant state of agitation, and make the employers' and officials' existence a burden to them by constant demands of all sorts, many of them utterly impracticable and unfair. When they cannot agitate against the employer they agitate against another Trade Union, and thus endless disputes spring up on the demarcation of work. Some of the worst strikes in the past have been due to disputes between two Trade Unions.

Unless something can be done to bring master and man together and make both work for the common good, English trade must inevitably go down, and the supremacy that England has in the engineering of the world will come to an end.

No truer statement was ever made than that recently made by Lord Joicey that this country, unless it produces as cheap or cheaper than other countries, cannot in the long run keep her trade, and this is true in spite of any tariff walls which may be set up. And if the present state of affairs is maintained of unscientific management and obsolete machinery, combined with limitation of output and high wages, or, in other words, high cost of production, we must, sooner or later, go to the wall.

What is really wanted is common honesty and common sense on both sides, for one side is as bad as the other at present.

And now about the official—of all grades, from the manager down to the foreman—who comes between the master and the man. Unless he is treated fairly by the master, and unless he treats his men fairly, there is sure to be friction and loss of efficiency. He must also work with his fellow-officials, who move in lines more or less parallel to his, and here, to obviate jealousies and to prevent the more unscrupulous among them taking unfair advantages, demarcation of each official's duties and work is most important. This is a point not always taken sufficiently into account in the organisation of a works, and the results are often most disastrous. The duties of each man should be clearly defined by the master

and no interference with those of others tolerated. The master also should remember that the official has no Trade Union or similar organisation to protect him, and should act accordingly. Much more could be said about the relations of the official both with his fellow-official who is on the same level as himself, with his master who is above him, and the workman who is under him, but time forbids. On all three sides much improvement could be effected. The fact remains, however, that for success it is essential that all, from the apprentice to the head of the firm, should work as one homogeneous whole.

Apart from the considerations set out above, combinations among the firms employed in any one trade are most essential for the well-being of that trade. It is by such combination that much of the progress made of late years by our competitors has been effected. Some of these combinations have been international, and at least two such in the engineering trade before the war were so. These now, of course, are, and it is expected will be after the war, confined to the allied and possibly to neutral countries, but such combinations, whether among all the engineering firms in one district or among firms employed in one particular trade, must be worked fairly to all members if they are to be successful. The larger firms must not override the smaller, as, it is regrettable to say, has been done in combinations of employers in some districts. For example, in a district where there is one firm very much larger than any of the others, the practice is not unknown for it to insist on everything being done to suit its requirements, regardless of the rights of others. Further, such combinations are liable, especially in case of emergency, to do much harm, unless directed by men with broad minds and able to take a wide view of things.

If the Armament Ring in this country had taken such a view when it was found what an enormous supply of munitions was required, it is doubtful if there would have been such a shortage as there has been. Hundreds of firms were willing and anxious to help in the production of munitions, but when they offered their services they were met in many cases with a blank refusal, and in all cases with little encouragement. And when, under pressure from the Government, the Ring accepted outside help, in many cases the conditions imposed on the sub-contractors were unfair in the extreme, apparently the whole idea of the Ring being to make all the profit they could out of the troubles of the Empire. It has been just as difficult to persuade the Armament Ring to give up what they thought was their monopoly and to bring in outside works to help in the production of munitions as it has been to persuade the Trade Unions to forego trade customs and to enable outside sources of labour to be employed, such as women and other unskilled labour. But both have had to do it. In other words, "Dilution of Works" has been as difficult to effect as "Dilution of Labour," and the position of both the Armament Ring and of the workman would have been very different if they had consented freely to it when it became obviously necessary for the safety of the Empire.

Combination among workmen is admittedly a necessity if they are to have fair play, but combination among employers has come later and is equally a necessity.

At present most of the principal federations of employers deal only with wages questions and questions affecting labour, but they require to be extended so as to take in all branches of the business of engineering. Labour has long seen the importance of federation, it is now for Capital to do the same. One of the great difficulties has been that certain firms would not join, and a very small proportion acting thus weakens the whole to a much greater extent than the actual ratio of this small proportion to the whole. It is easy to see how alive Labour is to this by the constant trouble over the non-unionist question, and this is well put in the notice addressed last March to the Transport Workers of the Mersey district, "To be outside a Union is to be disloyal not only to your own class but to yourselves individually." What applies to Labour also applies to firms, for a firm to be outside the Federation is to be disloyal not only to its fellow-firms but to itself.

Such a state of affairs is not tolerated in some of the countries competing with us, and it is questionable whether action by the Government is not advisable. An example of the mischief done by a few who would not fall into line with the many is seen by the necessity for the Act compelling the early closing of shops one day a week. The great majority were ready to close, but the action of a small minority prevented their doing so, and in the end compulsion had to be used on the minority. Legislation has not been necessary to prevent "blacklegging" in the labour world since other methods have been used which have been practically successful, but it is quite possible it may be necessary to use compulsion to make firms toe the line.

Such combinations are not only for labour questions, but also for all other subjects affecting the engineering industry at large, and more especially the special industries in which any one firm deals. Thus they resolve themselves into general federations of all engineering industries and minor ones dealing with particular trades. The former deal chiefly with labour questions and questions affecting the industry as a whole, the latter with those affecting any particular trade.

Among the questions coming up to be considered by the latter class is the standardisation of specifications and conditions of contracts, as well as in some cases the adjusting of prices to avoid unfair competition and to put the whole trade on a paying basis. Much has been done in this direction, with most advantageous results in certain cases, but much more remains to be done if this country is going to hold its place in the world.

The necessities of research work have already been dealt with, and by the pooling of such research work enormous advantages in any one trade could be obtained. Such pooling of information has been effected with most beneficial results, especially in the chemical trade abroad. Any workable scheme which would enable this to be done and get over the jealousies between one firm and another would be of enormous benefit to the trade in general.

Another thing that must not be lost sight of is the urgent need of improving our educational system. It is little short of a disgrace that the older Universities are closed to those without a knowledge of Latin and Greek.

Languages are of the greatest importance to an engineer —not dead languages but live ones. And these latter should be properly taught, so that the student should not only be able to read and write them but also to speak and understand them. It is quite a different knowledge of a language if one is able to read, write, speak, and understand it. Many people can read a language without being able to write, speak, or understand it, and, conversely, it is not uncommon to meet people who can speak and understand a language without being able to any large extent to read or write it. And it is only in live languages that a man is trained to speak and understand it.

Why is it that we are so wedded to the dead languages? There is, of course, the tradition that such are necessary for a liberal education, and there is the argument that modern languages are not as good a training for the mind. Granted that they are not quite so good from the point of view of learning to read and write them, does not the fact that they can also be taught as a live language to be spoken and understood make them on the whole the best educationally for a man? This is entirely apart from the fact that modern languages are useful and ancient languages useless to the man in commercial work. There is, of course, bitter opposition from that most conservative man, the schoolmaster, and one great reason is that it is much easier and cheaper to get a man to teach Latin and Greek than modern languages which have to be taught orally. The teaching of Latin and Greek as it is usually taught has been standardised to the last degree, and as a result they can be taught by the "semi-skilled" man, and a "skilled" man is not necessary, to use engineers' phraseology. In fact teaching of Latin and Greek is a pure "repetition job." At the same time no education is complete unless science is combined with languages and also literature, and here lies one great danger of modern technical education.

And after the boy has left school and enters the shops more facilities should be given to enable him not only to keep up but to continue his education. In the shops and drawing office too often the boy is left to pick up a knowledge of his trade as best he can. The apprentice who asks questions is often looked on as a nuisance, and requests for information are generally met by a blank refusal or worse. Often the foreman or chief draughtsman is afraid to answer questions for fear of being charged with giving away so-called "trade secrets," but an immense deal of information can be given to an apprentice without committing any such discretion.

Evening classes are all very good in their way, but more facilities should be given for the diligent apprentice to attend day classes, and this can be arranged in various ways if the employer has a will to do it. A thing that at present often prevents boys desirous of educating themselves getting on is the fact that overtime is allowed as soon as a boy is eighteen, and often he is compelled to work overtime regardless of classes that he ought to be attending.

It is important to remember that the boy of to-day is the man of to-morrow.

One complaint is that after a lot of trouble is taken about a boy he leaves after a few years and goes to another employer. The good of the trade in general must be considered, and a man who has had experience of various classes of work is generally a much more valuable man than one whose knowledge is confined to one class only. In any case the other employer gets the benefit of what has been done by the first, and thus the trade in general benefits.

It is felt that this is a very imperfect review of things as they are at present, but if this address induces all classes engaged in engineering to consider how things can be bettered the author feels that a part, at all events, of his object will have been attained.

STANDARDISATION AND ITS ASSISTANCE TO THE ENGINEERING INDUSTRIES.*

Introduction.—This paper has been prepared at the request of Professor Howe, who informed the Secretary of the Engineering Standards Committee that the Organising Committee of the British Association had decided to invite the presentation of a limited number of papers on subjects of national importance.

General Views on Standardisation.—In regard to standardisation as applied to engineering practice, much has been written, and it has, in fact, become so necessary to progress and is, indeed, so familiar to most of you that it will suffice on such an occasion as this to draw attention to a few of the more important aspects of the subject and at the same time place on record something of the success which has been achieved in this country of late through the effective co-ordination of individual effort.

It is scarcely necessary nowadays to insist on standardisation as being of paramount importance to economic production, but that was not so clearly seen 16 years ago, before the advent of the British Engineering Standards Committee. However, keen competition from outside, the legitimate demands of labour for a higher standard of living, coupled with the desire of capital for an adequate return, have compelled the whole industry to introduce modern order and system in all its methods of production, former individualistic methods giving way to co-ordination and collective effort. These improvements, which have already resulted in marked benefits, must not only be maintained, however, but continually added to if the full advantages are to be reaped.

The individual gain in private workshop standardisation is acknowledgedly great to the producer, for it tends towards interchangeability of component parts, facilitates quick delivery, and reduces maintenance charges and stores. In these ways it benefits also the consumer and the nation at large.

Crystallisation, however, which would tend to impede and to stultify progress, must be jealously guarded against if standardisation is to be of permanent value and the purchaser is not to be deprived of the benefit of competitive effort and inventive genius. Those responsible for the initiation of the standardisation movement in Great Britain realised from the first that in order to avoid undesirable stereotyping of practice it would be necessary from time to time to revise standards, and this has become recognised as an essential part of any standardisation work, which never can be regarded as final. In this way the community of interest of buyer and seller was, and is, realised through the acceptance by both of an agreed yet flexible standard.

Satisfactory results have been arrived at not by one section of the community imposing its opinions on the other, but rather as the result of co-operative action, mutual concession and ultimate agreement between all the interests concerned. The adoption of standards agreed on in this way undoubtedly promotes uniformity of practice, avoidance of waste, elimination of harsh and unnecessary conditions, reduction of manufacturing costs, and last, but by no means least, engenders a feeling of mutual confidence between user and producer such as could not be secured by isolated action on the part of either.

Experience, moreover, has shown clearly that such procedure does not lower the standard of quality, but tends rather to raise it, for standardisation carried out along these lines reflects, in effect, the consensus of opinion as to what constitutes best modern practice.

Successful standardisation can only be arrived at by common consent of all those who take full part in the initiation and working out of the actual details of the various specifications which are intended to be recommended ultimately for public use. The realisation of this guiding principle by the founders of the Engineering Standards Committee is probably one of the chief reasons for the wide adoption of the British Standard Specifications, which have no authority other than that of public opinion.

The Committee, its Inception and Growth.—The movement, as represented by the Engineering Standards Committee, the greatest voluntary effort of its kind, in which public spirit has been so lavishly shown, was founded in 1901, through the initiative of Sir John Wolfe Barry, K.C.B., who had long been coming to the conclusion that some means were urgently required to systematise design and production of component parts.

In 1897 certain remarks made by the late Lord Salisbury on the desirability of scientific physical standards and constants to an important scientific deputation, which resulted shortly afterwards in the establishment of the National Physical Laboratory, confirmed Sir John Wolfe Barry in his opinion, and in January, 1901, he laid the matter as affecting the engineering trades of the country before the Council of the Institution of Civil Engineers, with the result that a Committee was appointed to consider the question of standardising various kinds of iron and steel sections. The Committee reported favourably on the project, and the Council of the Institution of Civil Engineers adopted the report, and the co-operation of the five leading Engineering Institutions of the kingdom, viz.:—

The Institution of Civil Engineers,
The Institution of Mechanical Engineers,
The Institution of Naval Architects,
The Iron and Steel Institute,
The Institution of Electrical Engineers,

was subsequently secured. The original reference to the Committee was enlarged by resolution of all the Councils of the supporting Institutions, and full power was conferred on the Committee as to publication and the best manner of giving effect to their findings.

Thus from a single Committee, consisting originally of seven members, appointed to discuss the advisability of standardising rolled sections and rails, has grown the present far-reaching organisation with its 64 Committees and Sub-Committees, as well as numerous panels, including, in all, well over 500 members freely giving their time and experience, often at great personal inconvenience, and dealing with subjects embracing practically the whole of engineering practice. It is due to the memory of the late Secretary, Mr. Leslie Robertson, to say that the success of the Committee has been largely owing to his energy, foresight and conspicuous ability. His intimate knowledge of men and affairs, combined with sympathetic consideration for the views of all, enabled him to cope successfully with problems which otherwise would have presented more serious difficulties.

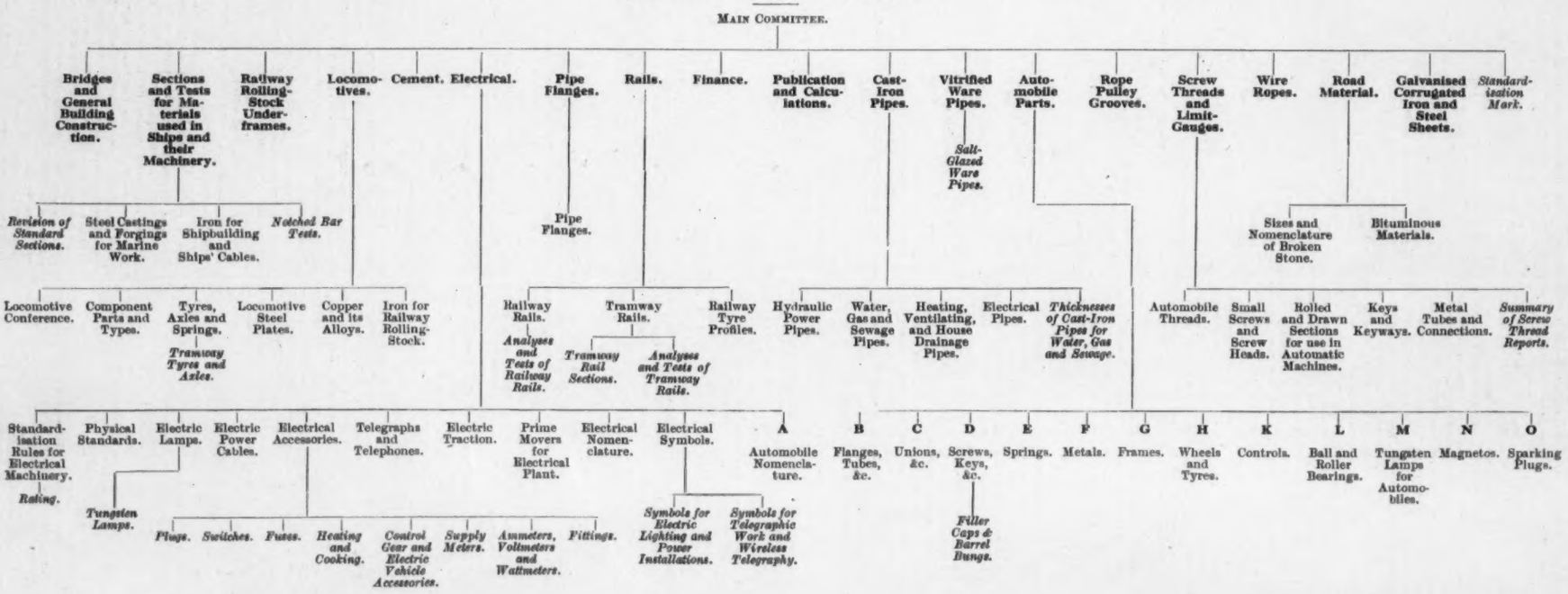
The internal organisation of the Engineering Standards Committee need only be very briefly referred to, as it is fully set out in the Report on Work Accomplished, which is issued annually. The Main Committee, which is composed of 19 official representatives of the five leading engineering institutions, has charge of the administration

* Paper read before Section "G" of the British Association on September 7, 1916, by the Secretary of the Engineering Standards Committee.

ENGINEERING STANDARDS COMMITTEE.

DIAGRAM SHOWING RELATION OF SECTIONAL COMMITTEES, SUB-COMMITTEES AND PANEL COMMITTEES TO THE MAIN COMMITTEE.

NOTE.—Sectional Committees are printed thus:—**Electrical.**
Sub-Committees " " :—Electrical Accessories.
Panel Committees " " :—*Supply Meters.*



of the whole of the work, the raising of the necessary funds, the controlling of the expenditure, the selection of subjects for standardisation, and the ratification of all reports and specifications presented by the various Sectional Committees for its approval prior to publication. The Sectional Committees are appointed by the Main Committee, who nominate the respective chairmen and arrange the mode in which the subjects are to be dealt with. The Sectional and Sub-Committees contain representatives of the various Government Departments, consulting engineers, manufacturers, contractors and users, as well as representatives from the technical societies and trade associations concerned.

The Main Committee only studies subjects at the request of the various sections of the industry concerned, and does not venture to make recommendations except on the initiative of the engineers or responsible representatives of the trade affected.

The utmost care is taken at the very outset to ensure that all who have or could possibly have any interest in the proposed standardisation shall be adequately represented (through their recognised societies and trade associations if such exist) on the Committee entrusted with the work. If necessary, evidence is taken, the advice of experts is sought, and in this way all parties are consulted and have a voice in the initial proposals, thus avoiding much subsequent friction which might otherwise occur.

In drawing up industrial standards, experimental investigations frequently become necessary in order to establish the facts underlying the principles involved, and in this connection the National Physical Laboratory has been and is conspicuously useful. It is in effect the Committee's official testing bureau, and its ultimate authority in matters concerning electrical and mechanical tests, acting in an advisory capacity in all the work in which unbiased experimental data are essential.

Each Sectional Committee is given an opportunity, once a year, of passing in review the specifications for which it has been responsible, for possible revision or addition if experience shows that such is desirable, and it is this system of keeping abreast of invention and progress which adds so greatly to the practical value of the work of the Committee.

The British Standard Specifications, which are confined to the main technical clauses necessary for the purchase of the product to which the specification relates, find an increasingly wide adoption. They are being increasingly adopted throughout the country, in home and export trade in general, and are also being largely substituted for the various and differing Government and Municipal Specifications formerly employed. They are proving of increasing value to the Crown Agents for the Colonies and the self-governing Dominions, and are, in large numbers, being sent abroad for use in the supply of engineering material required.

Success of the Movement.—As already mentioned, one of the first objects in the formation of the Committee was to simplify the rolling of steel sections for engineering structures and rails as well as shipbuilding material so as to save unnecessary cutting of a variety of rolls for no good reason and also to facilitate the making to stock during slack times. That the work of the Committee in this direction has been amply rewarded is shown by the fact that the number of rolls in use by British manufacturers has been largely reduced. As an instance, whereas there were formerly 70 sections of tramway rails, there are now only five. The same is true of all ordinary merchantable sections such as angles, tees and channels and rolled joists. The percentage of British Standard tramway rails to the total tonnage rolled during the year ended March, 1915, was 75 per cent., which is an indication that the number of standards recommended is adequate to meet all ordinary requirements. A considerable reduction has similarly been effected in regard to railway rails, and the work of the Committee is evidently of material benefit to the railway companies by the wide adoption of its findings and the substantial manner in which they financially support the Committee's activities.

Turning to the case of Portland cement, the British Standard is now generally adopted by engineers and manufacturers throughout the whole country, and the large number of copies of the specification which have been sold, 3,500 copies since the 1910 revision, goes to show its general utility to the industry. For 1913, the output of Portland cement of the country was over 3,000,000 tons, 95 per cent. of which, it is estimated, was made to British Standard.

The London County Council, in its General Powers Act, 1909 (Part 4), amending the London Building Acts so as to provide for the construction of steel frame buildings, has required that all rolled steel used in the construction of skeleton frameworks of buildings shall comply with the British Standard Specification for Structural Steel for Bridges and General Building Construction, and that all brickwork, concrete, stone, and other similar materials used in conjunction with the metal frameworks shall be executed in cement conforming with the British Standard Specification for Portland Cement.

It is estimated that 60 per cent. of the material used in the manufacture of railway rolling stock in Great Britain is made to British Standard. It would also appear from returns that for five of the largest steel works during 1913–14 the British Standard Sections totalled 95 per cent. of their output. The Sections recommended by the Committee for structural steel may be had from practically all the steelworks in the country.

The Admiralty has adopted the British Standard Specification for Steel for Marine Boilers, where steel of the tensile strength dealt with therein is required, the British Standard Specification for Structural Steel for Shipbuilding, and subject to certain additional requirements made necessary by the special character of naval work, the British Standard Specifications for Steel Castings and Forgings for Marine purposes. The Admiralty has also decided to adopt the British Standard Fine Threads (Report No. 20) for all bolts, nuts and studs for Marine work generally, and the War Office has specified them in many cases. The War Office has also adopted the British Standard Rim Diameters for Solid Tyres (Report No. 71).

The Board of Trade Rules for the survey of passenger steamships are in accordance with the British Standard

Specifications for Boiler Steel, Ingot Steel Forgings and Steel Castings. Lloyd's Register has adopted the British Standard Sections, and the Standard Specifications for Steel for Shipbuilding and Marine Boilers and for Steel Castings and Forgings for Marine purposes, and has incorporated these in its Rules. The British Corporation for the Survey and Registry of Shipping, and the Bureau Veritas have likewise given effect to the Committee's recommendations in their Rules.

The Admiralty has, moreover, taken the keenest interest in the electrical work and, in nearly all cases, has adopted the Electrical Specifications of the Committee, except where the exigencies of the service required departures owing to the special conditions which have to be met at sea.

The Indian Government and Indian Government Railway Companies, besides adopting the specifications of the Committee for manufactured work, requested in 1903 that the standardisation of types of locomotives be undertaken by the Committee and, in all, six broad-gauge and four metre-gauge engines have been standardised, and at the further request of the Indian Government designs for three more standard engines are in preparation. Since the issue of the first report in 1905 more than 1,600 standard broad-gauge and 700 standard metre-gauge engines, representing roughly about 7½ million sterling, have been built for India. Criticisms have sometimes been heard in regard to this policy of the Railway Board of India, but over 10 years of practical experience has evidently demonstrated the wisdom and economy of this policy, which might, with advantage, be followed by our home railways. Crystallisation of design and stagnation has clearly been avoided by the policy of a Standing Committee reviewing its recommendations at stated periods and adopting modifications as and when deemed necessary. Evidently the requirements of the locomotive engineers of the Indian railways are being met satisfactorily by the comparatively small number of standard types recommended.

The Home Office, in a memorandum on chains and lifting devices, notes the increased use of the two higher grades of wrought iron recommended by the Committee, and encourages their general adoption by chain makers. Also, in a recent Order in Council, the Home Office requires that the wattage of tungsten filament lamps used for automobiles shall be limited to the maxima given in the Committee's report dealing with that subject.

Much work has been carried out for the Road Board in regard to sizes of broken stone for roadmaking, and these recommendations, having been adopted, will doubtless be of increased assistance after the war.

Turning to the electrical side of the Committee's activities, it is interesting to note the large amount of preparatory work of importance which has been successfully carried through during the past two years. The most important electrical work completed is that of the Standardisation Rules for Electrical Machinery, in the preparation of which the Committee has received the cordial co-operation of the British manufacturers through their official organisation.

The conditions of the electrical industry in this country are very different from those existing either in Germany or America. In the United States two large Corporations deal with practically the whole of the business, whereas here there are some 40 or 50 firms more or less in competition with one another. However, conferences held both in London and in New York with the Standards Committee of the American Institute of Electrical Engineers, have resulted in the establishment of a thoroughly practical basis for the comparison of tenders for electrical machinery made in the United States of America or Great Britain, the rules of both countries being now in agreement on all essentials.

It is a pleasure to be able to place on record the Committee's appreciation of the courteous manner in which our American cousins have co-operated with their British confrères in this important matter, and the generous way in which they have dealt with the British criticisms of their original proposals. The result of such work cannot fail to exercise a most beneficial effect in doing away with misunderstandings, and so promoting fair dealing in international contracts.

Much also has been accomplished in one of the most difficult of tasks, the standardisation of small electric fittings with due regard to liberty in design. This work, in which again the makers' association has been most helpful, has occupied a great deal of time, and the difficulties and prejudices to be overcome have been great. Ordinary household wall plugs and sockets have at last been standardised as regards interchangeability. A specification to secure interchangeability between any charging plug and any socket of the type recommended by the Electrical Vehicle Committee of the Incorporated Municipal Electrical Association should be of material assistance in promoting the use of electric wagons and runabouts. A specification for electric supply meters has recently been evolved after much labour, and although some modifications may still be required, it is hoped that it may eventually prove satisfactory to both producer and purchaser alike.

A system of British Standard graphical symbols for use in electrical engineering plans is being drawn up, and in this work the Committee has the co-operation of the American and Canadian Electrotechnical Committees.

Reference to the Appendix will show the number of different subjects being studied by the Electrical Committees and upon which reports and specifications useful to the industry will be forthcoming in due course.

The ramifications of the Committee, as will be seen from the cases cited, are extremely widespread, and the commerce of the world, due to the increasing ease of communication, being largely international, one might almost say in spite of the artificial barriers set up by different nations, it is natural that the Committee should be forced to envisage co-operating internationally. The Sectional Electrical Committee, with a different chairman, is, *ipso facto*, the British Committee of the International Electrotechnical Commission, which has branch Committees in 15 to 20 different countries.

The complex nature of electrical machinery calls for different treatment, from the point of view of standardisation, than in the case of other engineering materials. Indeed, the problem of the rating of electrical machinery is, possibly, more intricate than is the standardisation of any simple pieces of mechanism, electrical or otherwise. The conductivity of the copper, the permeability of the iron, the mechanical strength of the materials, can be estimated with sufficient accuracy from the results of definite and easily carried out tests on samples. When the question of the insulating materials, however, is considered, the problem is, of course, very different, and one can but acknowledge that, owing to their inherent properties, the insulating materials employed at present come into an entirely different category. They are governed by no well-defined laws, as in the case of the copper and iron, their properties are variable and alter largely for very small changes in the conditions of manufacture as well as those under which they are employed in the completed machine. One of the important problems, therefore, is the settling of the limits which it is considered necessary to impose in order to ensure that the principal causes of destruction of the insulating materials, the heating combined with the time element, shall be well kept within safe limits.

A clear distinction exists also between an "international standard of quality" and an "international rating." The international acceptance of the former has already been brought about by the adoption, by the I.E.C. at its Berlin meeting in September, 1913, of certain limits of observable temperature applying to the materials in general use to-day. But these limits do not offer a means of comparing directly machines from various sources, since they would not necessarily have the same temperature rise. The fact, however, that American and British electrical engineers are at one on this point of immense commercial importance will doubtless have a great influence on the electrical industry of the world.

On all sides there are signs of strenuous preparations for meeting conditions after the war; science and industry are coming closer together, the commercial and technical sides inseparably linked together are being more efficiently organised, research work to assist manufacturers is being co-ordinated, finance is organising, combinations of commercial organisations are in the air; in fact, everything is being done with a view to strengthen British industry.

The German League of Economic Associations recently formed out of the six great Associations of German engineers, architects, furnace men, chemists, electricians, and marine engineers, numbering, so it is said, some 60,000 members, is an indication of what may be expected. Every effort must, therefore, be made to ensure that the British Standard Specifications are readily available to foreign purchasers as well as to those in the British Empire. A few of the specifications have already been translated into French, and it is hoped that satisfactory arrangements may be made to translate them all both into French as well as Spanish. In regard to Russian, the question is somewhat complicated, but in this case also the matter is being given the most careful consideration.

In conclusion, I cannot do better than refer to the views expressed by Sir John Wolfe Barry at Glasgow, in 1908, for they are true to-day! In many markets, formerly exclusively British, he said, we no longer hold supremacy, because, by quickness of despatch rather than through superiority of material or workmanship, our rivals have been able to beat us; but the work which has been effected by the Committee should very materially assist in keeping the trade of our great Colonial Empire in the hands of British manufacturers.

Sufficient evidence, you will agree, has been brought forward to show the great utility of the Committee's work to the engineering industry of the Empire. As regards the immediate future, so pregnant with vital issues to our trade, both home and export, the influential position of the Engineering Standards Committee as the central body, with its unique expert knowledge of standardisation, surely holds vast potentialities for good to the industry. The question of standardisation is, indeed, a national one and should be regarded in the broadest way possible. Undoubtedly it is exercising a profound effect on the industry generally and, if supported at home and abroad not only by the British Government but by all concerned, as it richly deserves to be, will, in the future, prove of incalculable value in furthering the legitimate aims of our British manufacturers, the products of whose workshops, for solidity, for efficiency and continuity of service, are second to none!

APPENDIX.

The following subjects have been, or are now, under consideration by the Engineering Standards Committee:—

Rolled Sections for structural purposes.
Railway Rails, Fishplates and Fishbolts.
Tramway Rails, Fishplates and Special Trackwork.
Light Flat Bottom and Bridge Rails.
Falling Weight Testing Machine for Rails.
Locomotives for Indian Railways.
Railway Rolling-Stock Material.
Railway Tyre Profiles.
Tramway Tyres and Axles.
Steel Castings and Forgings for Marine Work.
Steel for Shipbuilding and Marine Boilers.
Steel for Bridges and General Building Construction.
Notched Bar Tests.
Wrought Iron for use in Shipbuilding.
Wrought Iron for Railway Rolling-Stock.
Corrugated Iron and Steel Sheeting.
Steel and Iron Boiler Tubes.
Steel Wire Ropes.
Screw Threads and Systems of Limit Gauges for same.
Pipe Threads.
Pipe Flanges.
Screw Threads for Automobile Work.
Union Joints for Screwed Copper Tubes.
Screwed Copper Tubes and Fittings.
Screwing of Marine Boiler Stays.
Nuts, Bolt Heads and Spanners.
Bright and Black Washers.
Rolled and Drawn Bars for use in Automatic Machines.
Small Screws and Screw Heads.
Keys and Keyways.
Rivet Heads.
Systems of Limit Gauges for Running Fits.
Portland Cement.
Salt-Glazed Ware Pipes.
Concrete Pipes.
Cast-Iron pipes for various purposes.
Road Material.
Automobile Parts.
Profile of Rope Pulley Grooves.
Definitions of Yield Point and Elastic Limit.
Method of Sampling and Testing Coal.
Generators, Motors and Transformers.
Prime Movers for Electrical Purposes.
Carbon and Metal Filament Glow Lamps.
Bayonet Socket Lamp Holders and Caps.
High-Tension Dielectrics.
Insulating Materials.
Telegraph Material.
Electric Cables.
Hard-Drawn Copper and Bronze Wire.
Electric Tramway Motors and Material.
Method of Specifying Resistance of Steel Conductor Rails.
Tubular Tramway Poles.
Ammeters, Voltmeters, Wattmeters, Frequency Meters, &c.
Ceiling Roses.
Steel Conduits for Electrical Wiring.
Consumers' Electric Supply Meters.
Plug and Socket Devices for Electric Lighting, &c.
Tumbler Switches.
Fuses.
Cable Lugs.
Cells and Containers for Electric Traction.
Battery Charging Plugs for electrically-propelled vehicles.
Motor Starters and Controllers.
Electric Cooking Apparatus.

AMERICAN PETROLEUM.—The quantity of petroleum marketed in the United States in the first half of this year is estimated by the American Geological Survey at 140,000,000 barrels. This total is made up as follows: Appalachian range, 11,400,000 barrels; Lima-Indiana district, 1,800,000 barrels; Illinois, 7,900,000 barrels; Kansas and Oklahoma, 50,500,000 barrels; Northern and Central Texas, 4,200,000 barrels; North-West Louisiana, 6,800,000 barrels; Gulf Coast, 11,400,000 barrels; Wyoming and Montana, 2,400,000 barrels and California, 43,500,000 barrels.

THE NOTTINGHAM SOCIETY OF ENGINEERS.—The first meeting of the 1916–17 session will be held at the Welbeck Hotel, Nottingham, on Wednesday, October 18, at 7.30 p.m. The council wish this meeting to be given to the reading and discussion of short papers on engineering subjects, and therefore invite members to submit such papers, which should not take more than 10 minutes to read. Six papers will be read by an independent reader, and members will then be asked to vote for the two best papers, so they can be discussed and prizes awarded. All papers should be sent to Mr. J. F. Chambers, The Elms, Daybrook, Nottingham, by October 2.

CALCUTTA WOOD PAVING.—The Chief Engineer of the Calcutta Corporation, says *Indian Engineering*, has presented a report on wood paving in Calcutta. After reviewing the history of wood paving in Calcutta from 1902, he deals with the wood paving experiment made in Hastings-street, on which he reports adversely, as follows:—"Although laid only a short time before, the wood paving in Hastings-street showed symptoms of failure during last year's rains, as the expansion joints left at the sides had all been used up in less than two months. During the rains this year this defect increased still further, the pavement burst up in places, and the blocks had to be taken out and relaid. Two sets of expansion joints have already been used up, and a third had to be provided recently to prevent another and immediate burst up. By frequent attention and increasing the room for expansion there is no doubt that wood paving can be kept *in situ*, but such increase of room for expansion means that when the dry season comes on the blocks will separate and leave wide joints as they shrink individually. The process will very materially shorten the life of any wood block pavement, as the blocks will lose their mutual support and consequently wear and crush at the edges, thus producing a curved surface on the top face of the block, instead of the original flat surface. Furthermore, if there was any considerable mileage of wood pavement in Calcutta this periodical tinkering with the outside blocks, in order to allow more and more room for expansion, would not be a practical proposition. The condition of the pavement in Hastings-street is still good, and there is little, so far, to choose between the three sorts of timber laid, viz., sal wood, American creosoted Douglas fir and krabark, but the Douglas fir is certainly wearing in an more even manner than the other two timbers, which agrees with European experience that soft wood blocks wear more evenly than hard wood blocks. In conclusion, I have only to add that I am convinced, now as heretofore, that wood block paving can never be a success in Calcutta, or any place with a similar climate to Calcutta, and I am, therefore, of opinion that no more of it should be laid, and the Government Forest Economist should be asked not to incur any more expense in preparing wood blocks for Calcutta."